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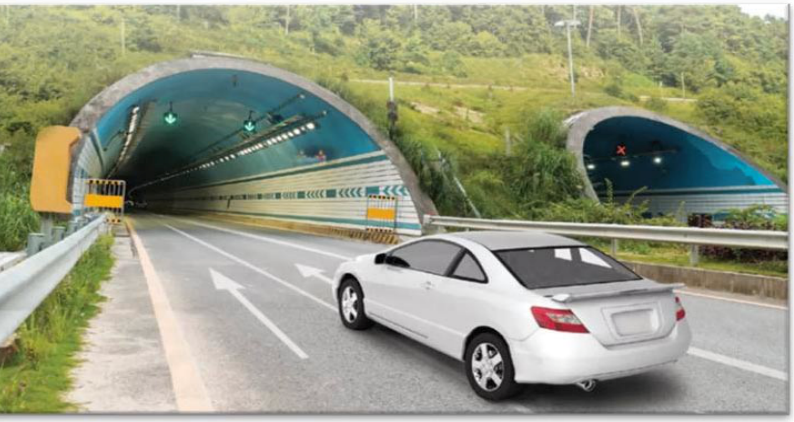


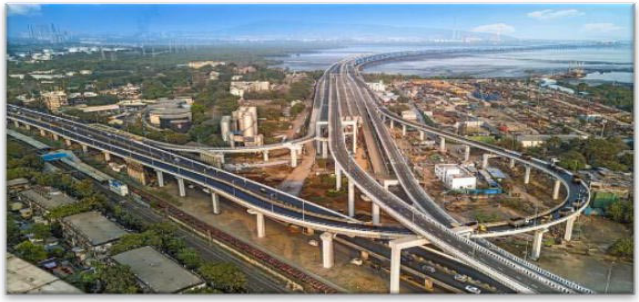


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FROM THE EDITOR-IN-CHIEF

"We can overcome every challenge and build a prosperous Bharat and achieve the goal of a 'Viksit Bharat' by 2047"

Shri Narendra Modi, The Prime Minister of India

Transforming Housing and Urban Development to achieve the goal of *'Viksit Bharat'* by 2047

As India strides toward its centennial of independence in 2047, the vision of a Viksit Bharat (A developed India)—a developed nation, stands as a beacon of ambition and hope. Transformation of housing and urban development, the sectors that underpin economic growth, social equity, and environmental sustainability are central to this vision. Over half of India's population is projected to live in Indian cities by 2047, the nation faces both a challenge and an opportunity to redefine urban living for the 21st century.

Housing is much more than just shelter; it is the bedrock of dignity, security, and opportunity. India has experienced rapid urbanisation in recent decades, driven by significant increase in economic activities and rural-to-urban migration. For improving the living conditions of the people, government is accelerating the infrastructure development. The government of India's flagship *Pradhan Mantri Awas Yojana* (PMAY) has made commendable achievements, with over 10 million houses constructed since its launch in 2015 which indicates a quantum leap through scaling up affordable housing while ensuring quality, accessibility, and resilience.

Urban development, meanwhile, would have to evolve beyond patchwork solutions. India's cities, from bustling metropolises like Mumbai to emerging hubs like Guwahati, are engines of economic activity, contributing over 60% of the India's GDP. However, our cities do grapple with congestion, pollution, and inadequate public services. Government of India's various mission programmes, such as the *Smart Cities Mission* has laid an excellent groundwork for technology-driven urban planning, but the scale of India's urban challenge calls for a much broader and more inclusive approach.

A roadmap for 2047

To realise the goal of Viksit Bharat, housing and urban development sector need to align with three key pillars: affordability, sustainability, and innovation.

Affordability through scale and policy framework

The rising cost of land and construction threatens to exclude low- and middle-income families from urban prosperity. Public-private partnerships (PPPs) can unlock vast tracts of underutilised government land for affordable housing projects. Tax incentives for developers, coupled with streamlined regulations, would help accelerate construction of housing for urban poor. Additionally, expanding rental housing—relatively, hitherto a neglected segment, would provide flexible options for migrant workers and young professionals, reducing the pressure on ownership-driven models.

Key emphasis on sustainability

India's urban future development need to increasingly integrate sustainability principles, with climate change posing existential risks in some regions, new housing projects need to incorporate energy-efficient designs, solar and other alternate energy integration, and rainwater harvesting. Urban planning would have to prioritise mixed-use developments to reduce commute times and carbon emissions, while expanding green spaces to combat heat islands. The government's push for net-zero cities, inspired by global models like Singapore, would set a precedent. Retrofitting existing structures, too, will be critical to ensure that old-city area are not left behind.

Focus on innovation

Technology have lot of potential to transform development landscape. Prefabricated construction techniques could help reduce cost and time of construction, making housing projects financial and economically viable, in even the most remote urban fringes and inaccessible places. E-Governance has already made significant effect on ease of accessing civic services by citizens, while AI-driven urban planning would help optimise traffic, waste management, and resource allocation. India's startup ecosystem, already a global force, need to be further incentivised to further provide solutions in areas like housing and urban services thereby fostering a self-reliant *(Atmanirbhar)* approach.

Bridging the Rural-Urban Divide

A *Vikshit Bharat* would also need to lay due emphasis on the development of our rural areas. As urban centres grow, peri-urban zones, the transitional areas between cities and villages, will become critical. These regions would need planned development to prevent the chaotic urban sprawl seen in today's megacities. Satellite towns, around the main cities (mother cities), equipped with modern amenities and connected by well laid transport networks, would decongest urban cores while offering affordable housing options. The *Rurban Mission* could be further finetuned to ensure these areas blend the best of rural resilience and urban opportunity.

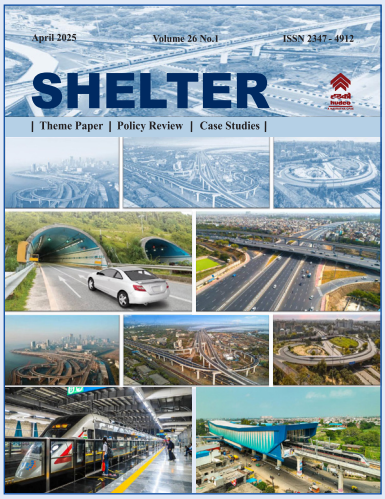
Equity to play a pivotal role

Urban development would need to give priority to the needs of the marginalised communities such as slum dwellers, workers in the informal sector, and women. Redevelopment of slums for providing adequate shelter with civic amenities to low-income communities, with legal titles for residents, can help break cycles of poverty. Women, who often bear the brunt of inadequate housing, need safe, accessible spaces with proximity to schools, healthcare, and livelihood. Therefore, inclusive planning, informed by community participation, will ensure no one is left behind in this journey to *Vikshit Bharat* by 2047.

The Path ahead

The government's commitment to *Viksit Bharat* is very clear, however its success would be dependent on its execution. Financing the development projects could pose significant challenges, which would necessitate increased budgets for housing and urban development especially for urban infrastructure augmentation including its operation and maintenance, which would need to be supplemented by innovative financing models like

INSIDE



municipal bonds and international green funds. Capacity building, both at the local level and regional level, as well as at the central level, would help in empowering urban local bodies (ULBs) technical skills, with resources and needed functional and operational autonomy. Further, adopting a comprehensive participatory approach through engaging citizens, entrepreneurs, and civil society, would certainly help transform this ambitious vision into a collective mission.

In this regard, strengthening our urban local bodies (ULBs) by empowering them with facilitating access to institutional finance would be crucial for enabling them for effectively delivering quality basic services and for which further decentralisation of powers as envisioned in the 74th Constitutional Amendment would need to be implemented fully. In addition, adoption of good governance practices, including digitally enabled services, through use of GIS, data analytics and AI, would help in ensuring efficiency, transparency, rooting out malpractices like corruption, and thereby improving customer/ citizen satisfaction.

We trust and are confident that by 2047, Indian cities would stand on global stage, as exemplars of progress—vibrant, inclusive, and sustainable. Basic human needs such as housing, would cease to be a privilege and would have become a right. Although the path is very ambitious, but so is India's spirit. With bold and people-centric policies, relentless innovation, and unwavering resolve, *Viksit Bharat* is not just a dream—it is a destiny within reach. Let us build it, brick by brick, city by city, until the goal is realised.

In conclusion, we wish to reiterate that the journey towards *Viksit Bharat* 2047 is a collective endeavour. By prioritising housing and urban development with focus on infrastructure development, India can ensure a future where every citizen benefits from a developed nation with equitable, and sustainable environment. Together, we can, and we will, transform this vision into a reality, leaving a legacy of progress for generations to come.

This edition of Shelter contains articles by various urban practitioners having rich and long experience in the habitat sector on the themes such as role of climate resilience, people's participation in governance and formulation of citizen-centric polices and programmes, in addition to case studies showcasing various initiatives, innovative planning and design approaches and implementation. We hope that readers would benefit immensely and would contribute to the discourse on role of urban sector in achieving the goal of *Viksit Bharat* by 2047.

Theme paper

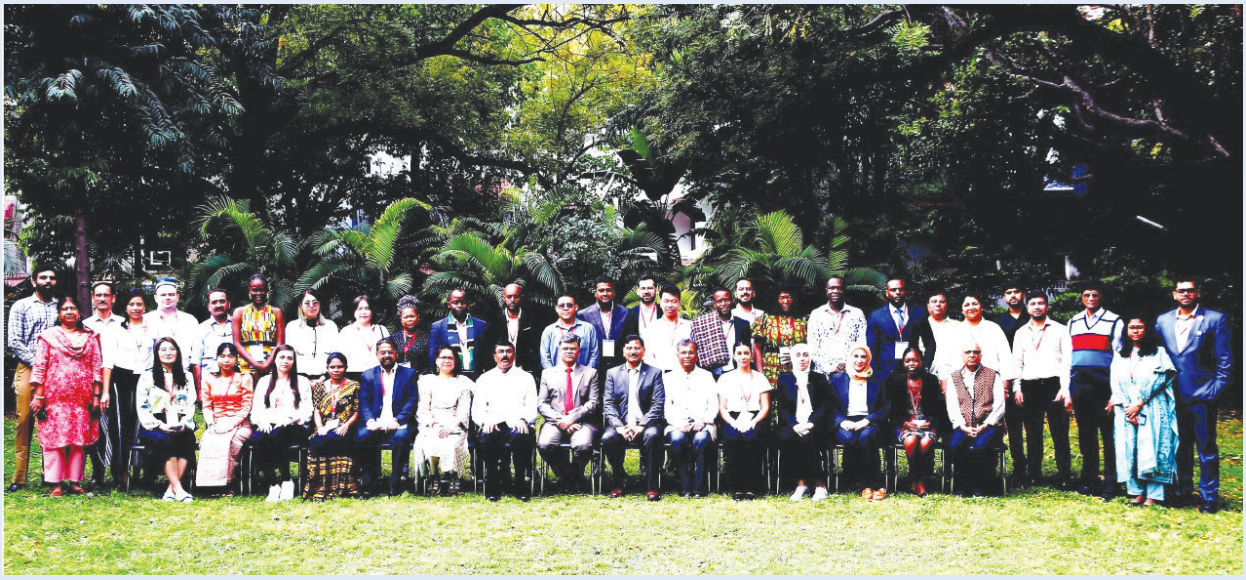
Policy Review

Case study

IN THE BOX

Two week Course for Overseas Professionals on "Right to Adequate Housing in the context of Habitat III New Urban Agenda - Policies, Planning And Practices Under ITEC" *(March 12 - 25, 2025)*

HUDCO's Human Settlement Management Institute (HSMI) organised the 56th Training Programme for overseas professionals on "Right to Adequate Housing in the context of Habitat III -New Urban Agenda - Policies, Planning and Practices" sponsored by the Ministry of External Affairs(MEA), Government of India under its ITEC Programme during March 12 - 25, 2025. The programme was inaugurated by Shri Sanjay Kulshrestha, Chairman and Managing Director, HUDCO on March 13 , 2025 in the presence of Shri M Nagaraj, Director (Corporate Planning) HUDCO, Shri Daljeet Singh Khatri, Director (Finance) HUDCO, Shri S P Tripathi, Senior Executive Director HUDCO and Ms. Varsha Punhani, Head, HUDCO's HSMI.



56th ITEC batch of overseas professionals with Shri Sanjay Kulshrestha, Chairman & Managing Director HUDCO and Senior Officers of HUDCO and HUDCO's HSMI

The training programme was attended by 25 delegates from 22 countries namely Cape Verde Island, Ecuador, Ethiopia, Ghana, Iraq, Kenya, Laos, Lesotho, Malawi, Mauritius, Mexico, Mongolia, Myanmar, Nigeria, Paraguay, Romania, South Sudan, Sri Lanka, Tajikistan, Tanzania, Thailand and Vietnam. The programme was conducted on participatory lines with deliberations and insights from the domain experts as well as the participants. In addition to HSMI Faculty, the technical inputs were delivered by experts drawn from the Government sector, private sector and academia. The notable speakers invited to take sessions included Prof. Amitabh Kundu, distinguished fellow at Research and Information System for Developing Countries; Ms. Banashree Banerjee, Independent Consultant & Associate Staff Member, IHS-Rotterdam; Ms. Mukta Naik, Fellow, National Institute of Urban Affairs (NIUA), New Delhi and Dr. Ruchita Gupta, Asstt. Professor, School of Planning and Architecture (SPA), New Delhi.

During the course of two weeks, the participants were exposed to the concepts and various aspects of right to housing, affordable housing, emerging technologies, *Pradhan Mantri Aawas Yojana* (PMAY), housing and urban development policy frameworks and financing models for affordable housing. The technical sessions were interspersed with visits to project sides and places of cultural and historical importance in Delhi. The participants were also taken on an outstation trip to Chandigarh - the first planned city of independent India and on a day trip to Agra.

GREENING BUILDING AND CONSTRUCTION SECTOR FOR A VIKSIT BHARAT

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India, a land of ancient brilliance, aims to become a developed nation, "Viksit Bharat," by its 100th year of independence. Achieving a goal of this magnitude would require a significant investment in infrastructure development, which at present is to the tune of 3.3 percent of GDP. However, the major obstacle in the journey is the high carbon footprint of the building and construction sector. Transitioning to green buildings is imperative to pave the path to sustainability by 2047. Even though adoption of green buildings is accompanied by several challenges such as perceived costs, demand supply and design gaps, lack of knowledge etc., it can be made possible by the adoption of strategic roadmap which insists on strict implementation of regulatory frameworks, incentive mechanisms, cross-sectoral partnerships, integrated planning, community engagement and adoption of green building certification systems. Greening the building and construction sector is not a choice, but a necessity that can be made possible by blending India's ancient wisdom with modern technologies to build a sustainable future.

India has been a land of ingenuity and intelligence since times immemorial. While there have been numerous significant inventions, a few aspects that make India's contribution monumental, are the invention of Zero in Mathematics, Ayurvedic Medicine and Yoga in well-being.

Architecturally, one of the most advanced ancient civilisations in the recorded history, is the Indus Valley Civilisation which originated in the Indian sub-continent and flourished in, what is now the north-west India and present-day Pakistan. The civilisation known today for its advanced urban planning and infrastructure, underground drainage system, wide streets, citadels, mud bricks and gypsum mortar, grid pattern planning and great bath (Who were the Indus people? KS2, Bite size, BBC), still stands as one of the most 'sophisticated' civilisations of all times (Watson T, April 30 2013, Surprising Discoveries From the Indus Civilisation, National Geographic).

Nalanda University serves

as a testament of the deep respect for mother nature demonstrated by Indians, which was masterfully combined with architectural concepts that were modern yet harmoniously nestled in the serenity of the environment (Nalanda University, India map Digital). Ancient forts and palaces of India stand today as our engineering and architectural marvels showcasing exemplary water conservation methods in the form of step-wells or *Baolis* and passive architecture techniques to enhance energy efficiency that guided the pre-colonial architecture through harsh climatic conditions.

The glorious image of India attracted many foreign invaders and gradually the country lost its wealth and infrastructure to the dark era of invasion that ended in 1947. Ruled for 200 years by the Britishers, the country limped back to where it is positioned today by the contribution of every Indian national. India emerged as a strong democratic power globally having finest educational, medical & research facilities such as IITs (Indian Institute of Technology) , IIMs (Indian Institute of Management), AIIMS (All India Institute of Medical Sciences), NITs (National Institute of Technology), BARC (Bhabha Atomic Research Centre), ISRO (Indian Space Research Organisation) and DRDO (Defence Research and Development Organisation), just to cite a few. Today India has secured the 39th position among 133 global economies in the Global Innovation Index (GII) and this exemplifies India's unwavering commitment towards creating a robust ecosystem that has a strong foundation of effective policies and cross-sectoral approach (Kumar S, Sarla M, Nair A, Sep 30 2024, India's Impressive Leap in the Global Innovation Index 2024: A Testament to the Nation's Growing Innovation Ecosystem, Press Information Bureau, Government of India).

We are a developing nation today, and in our 100th year of Independence, India aspires to be a developed nation or Viksit Bharat. With an estimated population of 1.48 billion people, it is as much a challenge as an opportunity. As we aim to be a developed net zero economy by 2070, the building and construction sector would be at the forefront of this transition.

A 3.3% of India's GDP (Gross Domestic Product) has been allocated to the infrastructure sector in the year 2024 to achieve the developed nation status (Mohapatra S, Pohit S, Aug 10 2024, Building infra at the core of Viksit Bharat, The Financial Express, NCEAR). A report by World Bank Group suggests that about 70% of India's urban infrastructure is yet to be built by 2047 (Kouamé AT, Jan 30 2024, Gearing up for India's Rapid Urban Transformation, World Bank Group). This ambitious journey needs to be undertaken carefully as the world grapples with the challenges of climate change strongly attributed to the building and construction industry.

Building and Construction industry is significantly resource intensive and is leading to mass deforestation, depletion of non-renewable resources, extensive mining and many such critical global impacts. The built environment generates nearly 42% of annual global CO_2 emissions; 27% of these emissions are attributed to building operations that includes energy and water consumption, post-occupancy solid waste generation, operation & maintenance protocols of the systems installed, etc. while building materials and construction are responsible for an additional 15% (Why The Built Environment? Architecture 2030). The boom in construction activities coupled with heavy reliance on non-renewable energy sources, unsustainable urban planning, poor building design, and overall absence of sustainable sensitivity have all amplified CO_2 emissions. Consequently, the building

industry has become one of the key contributors to global warming, and has the largest capacity to substantially reduce carbon emissions via resource efficient and low-cost interventions as well. A deliberate shift from conventional to building green is imperative.

What are Green Buildings?

Green buildings are a very scientific and integrated response to the challenge of soaring carbon emissions in the environment from the building and construction sector. A building that is designed considering the local site conditions and the prevailing climatic conditions utilises minimum natural resources and relies on locally available materials.

These buildings are aimed at minimising the consumption of non-renewable resources, maximising renewable resource integration, and implementing the concept of reuse and recycle. The design of green buildings lays emphasis on:

- making maximum use of sun and wind movement, existing vegetation and contours, drainage patterns, efficient building materials and construction practices, efficient equipment to provide visual and thermal comfort
- utilising renewable sources of energy.

It puts on priority the concept of waste to resource and focuses on waste management and water conservation practices. The ultimate outcome of a well-conceived building design yields a comfortable and resource efficient structure that integrates seamlessly with its natural environment. These buildings emerge from a systematic and collaborative process where architects, landscape designers, engineers, consultants, and contractors work in unison across all phases of design, space planning, material, and equipment selection to commissioning and maintenance. Critical analysis of every decision taken during a project design is essential to reduce the environmental impact of the project while making it cost-effective at the same time.

Challenges in the Adoption of Green Buildings

While there are multiple benefits of green buildings, the market share of these buildings is as low as 10%in the country (Goel, M. 2024). The various issues identified in the adoption of green buildings are as follows:

- Myth that green buildings are 'expensive'- coming from an era where green buildings were a new concept, the notion of green buildings being 'expensive' still dominates the market. However, it is to note that a climate responsive design that leverages local materials and site conditions significantly lowers the energy and water consumption of a building, thereby reducing the initial cost and shortening the payback time of a project significantly. Moreover, the concept of green building should be an intrinsic part of the design process and not a mere add-on as renewable resource or efficient systems on a poorly designed high resource consuming structure.
- Lack of implementation frameworks and incentive mechanisms to support green construction
- Lack of green building materials & technology related data: Data that gives assurance to developers on the durability and strength of such materials and technology is not easily available in the market. Most of the green building specific data is not available in public domain that restricts building practitioners from adopting a certain innovation in the green building sector.
- Lack of knowledge and awareness among home buyers and developers:

The climate issues and green building benefits are unknown to a significant portion of our developer and buyer population, leading them to perceive it solely as an added cost.

- Lack of local technical skillset and labour- In many parts of the country, construction labourers are not skilled to work with the evolving market trends. For example, the right way of laying AAC (Autoclaved Aerated Concrete) blocks is still unknown to them which leads to issues of crack development in AAC walls. This is often considered as a material specific challenge which discourages the use of AAC materials.

Roadmap for Sustainable Construction

The vision to construct all new buildings as green, necessitates an integrated and adaptable roadmap which draws wisdom from traditional architectural knowledge while incorporating the latest advanced technologies. For the building and construction sector to embrace green building revolution in earnest, several steps must be adopted:

- Strong Governance and Regulatory Frameworks
  - Green building codes and standards have been established in India that ensures minimum resource consumption and maximum occupant comfort. A strong governance must ensure that any new construction or renovation adheres to these codes without fail.
  - Institutional capacity must be strengthened for sustainable planning, implementation, and monitoring.
  - Transparency must be maintained through open data initiatives along with public reporting.
- **Incentive Mechanism:** Several Indian state governments offer incentives of varying nature for the promotion of green buildings, however, a few states still lag. Incentive models such as tax benefits, subsidies, fast track approvals, interest free loan on green building purchase can encourage both developers and buyers to go for green buildings.
- **Monitoring and Evaluation:** It is vital to establish robust monitoring and evaluation mechanisms that track the sustainability performance of projects over years and identify the areas of improvement. Performance dashboards, stakeholder engagements, data analytics tools and stakeholder engagements can be adopted to ensure the same.
- Integrated Designing and Assessment
  - Cornerstone of green construction is integrated spatial planning. This involves conducting thorough environmental impact assessments (EIAs) and strategic environmental assessments (SEAs) to identify potential risks and mitigation measures, and planning accordingly.
  - Life-cycle assessments (LCAs) should be implemented to assess the environmental footprint of projects from construction to decommissioning, enabling informed decision making at every stage of a building's lifecycle.
  - With erratic weather patterns witnessed globally as an outcome of climate change, climate change vulnerability assessments become important for embedding resilience in the built structure. Climate resilient buildings are designed to withstand and minimise damage

that may occur from future climate impacts such as temperature fluctuations and sea-level rise.

- **Promoting Circular Economy**
  - The most efficient way to ensure resource efficiency is to adopt a culture of circular economy that does not shy away from reusing and recycling waste and converting them into resources.
  - Utilisation of industrial waste, construction and demolition waste and sustainably procured timber along with bio-based materials becomes crucial in ensuring resource efficiency.
  - Defining value chain responsibility is vital for the adoption of circular economy. The Government of India has been actively working towards adoption of industrial waste and recycled content in construction industry. For instance, the Ministry of Environment, Forest, and Climate Change (MoEFCC) has issued various mandates regarding the use of fly ash in cement industry that fall within 300 km from coal or lignite-based thermal power plants. Usage of Construction and Demolition (C&D) waste is being promoted by various frameworks and guidelines drafted by the Ministry of Housing and Urban Affairs (MoHUA), NITI Aayog, and CPCB (Central Pollution Control Board). In a nutshell, the government has been taking requisite actions in terms of setting guidelines and policy frameworks. However, it is vital to define value chain responsibility, to create awareness and bridge the demand and supply gap.
- **Availability of reliable open-source data:** Effectiveness of green building strategies can be firmed up with validated data on material properties and lifecycle, building certifications and performances, carbon emissions etc. Transparency and data availability in the market can build trust and encourage investment in green buildings.
- **Joint Sector Approach and Alternative Funding Solutions**
  - Fostering public-private partnerships (PPPs) can play a critical role in supporting and funding sustainable construction.
  - Adopting innovative financing initiatives such as green bonds, carbon credits and impact investments can mobilise capital for sustainable construction.
- **Community Engagement and Public Awareness**
  - Organising open workshops and seminars to educate general masses about green buildings and environmental issues can be pivotal in the green building revolution.
  - Engaging local communities of students and youth by hosting green building fairs to imbibe sustainability at the right age can be very effective.
  - Adopting innovative approach at grassroot level such as social impact assessments to evaluate the potential effects of climate change on communities and mitigate negative impacts can stimulate critical thinking.
- **Promoting Green Building Certification Systems**
  - Green building rating systems

are meticulously formulated guidelines for the construction and renovation of buildings to minimise their negative impact on environment throughout the lifecycle of these buildings, thereby minimising carbon emissions through building sector. These rating systems evaluate buildings and validate their performance. These performance numbers can help government in understanding the status of the sector in achieving net zero goal for a Viksit Bharat.

- These ratings systems should be mandated for all public, private buildings and incentive mechanisms should be established to encourage stakeholders to promote green buildings.
- India's own green building rating system, GRIHA (Green Ratings for Integrated Habitat Assessment) was rolled out in the year 2005 by TERI (The Energy and Resources Institute) by the support of Ministry of New and Renewable Energy (MNRE) for adoption and promotion of green buildings in the country. Other validated rating systems do exist as well in the market to choose from.

The journey to Viksit Bharat is strenuous, nevertheless, it is full of opportunities. It is a vision that can be turned into reality through collaborative efforts of government, industry stakeholders and individuals.

The building and construction sector becomes the key indicator of a nation's global standing that has profound effect on both its environmental footprint and its citizen's lifestyle. Therefore, this sector holds significant responsibility, which it must shoulder, in contributing to a Sustainable Viksit Bharat that has a strong foundation of time-honoured wisdom supported by contemporary technological advancements. Building green is no longer a choice but a necessity in face of accelerating climate change and India must embrace this idea to prove its global competitiveness and safeguard mother nature.

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PHILOSOPHICAL PARADIGMS ATTEMPTING TO ENCAPSULATE THE PATHS TOWARDS A VIKSIT BHARAT 2047

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India is on track to become the third largest economy by fiscal 2030-31, driven by a robust projected annual growth rate of 6.7, the credit rating agency S&P global said in its report named 'India Forward: Emerging Perspectives'. This rapid economic ascent reflects remarkable strides India has made in recent decades. The nation has witnessed consistent annual growth rates averaging 7% over the past two decades, with the services sector emerging as the primary engine of growth, accounting for more than 50% of the GDP. Key industries such as information technology (IT), business process outsourcing (BPO), and Fintech have positioned India as a global leader in innovation and technology.

The Indian government's initiatives, including the 'Make in India' program, is also fostering growth in the manufacturing sector. Despite these impressive figures, India faces significant challenges. Income inequality remains a persistent issue, with the wealthiest 1% controlling a disproportionate share of the country's resources. Unemployment, particularly among youth and women, infrastructure deficits, and disparities in access to education and healthcare continue to hamper the country's progress toward holistic development. These challenges underscore the complexity of India's vision for a Viksit Bharat (Developed India) by 2047, the centenary of its independence.

India's vision for 2047 is not merely focused on economic growth but aims to achieve inclusive and equitable development that benefits all citizens. The Govt. of India's various programmes and schemes like the Pradhan Mantri Awas Yojana, NREGA, PMJDY, AMRUT, Smart Cities Mission, PMUY, FAME India, NEMMP, Bharatmala Pariyojana, PMGDISHA aspire to work towards this goal. This vision is deeply rooted in both Indian and Western philosophical traditions, which provide guiding ethical frameworks to shape policies that balance economic prosperity with social justice, sustainability, and human well-being. The principles of Dharma, Sarvodaya, and Vasudhaiva Kutumbakam from Indian philosophy, alongside Western ideas of Utilitarianism, Justice, and liberalism, form the philosophical foundation for India's development model.

Introduction

India, the world's largest democracy and one of its most dynamic economies, stands on the threshold of a transformative era. As India sets its sights on becoming a Viksit Bharat (Developed India) by 2047 marking the 100th year of its independence, its path forward will integrate and be supported by the pillars of inclusive growth, economic expansion, sustainable infrastructure, environmental stewardship and digital innovation. It is one of India's most ambitious yet challenging programmes yet.

A developed country is expected to provide excellent quality of life for its citizens, enhanced levels of infrastructure and economic prosperity. Through government initiatives and a commitment to the moral values of both Eastern and Western thought, India aspires to create a society where prosperity is shared, opportunities are equitable, and development is sustainable. This vision of progress will guide India through its complex journey toward becoming a truly developed and globalised nation in the next quarter-century. This multifaceted development agenda while being contemporary is grounded in both Indian and Western philosophical traditions, reflecting an integration of material progress with human well-being, equity, and social justice. These pillars are not independent but intertwined and mutually reinforcing, representing India's holistic approach towards development. To navigate this journey, India must address significant challenges while drawing inspiration from diverse philosophical thought to create a future that is both prosperous and just for all.

In their book "Why Nations Fail, The Origins of Power, Prosperity and Poverty", Daron Acemoglu and James A. Robinson, the joint Nobel Prize Winners in Economics for the year 2024, have argued that it is not climate, geography or culture which causes some nations to be more wealthier and prosperous than others, but essentially the advantages reaped through the presence of virtuous political and economic institutions which are non-extractive thus providing secure and inclusive development triggering a cycle of prosperity. In this context the core emphasis of our policies and the philosophical ideology behind them is crucial.

The bedrock of India's development strategy for 2047 undoubtedly emphasises inclusive and equitable development. India's diversity based on ethnic, cultural, economic and geographical grounds certainly is a matter of pride, however this very multifaceted concept of diversity itself poses unique challenges exclusive to us in ensuring that all segments of society benefit from progress equitably. Economic inequality, social exclusion, and discrimination based on caste, gender, and religion still continue to be major hurdles to development.

For instance, gender-based inequality remains one of the most pronounced issues in India. Despite socio-economic upliftment in certain aspects, women continue to face challenges in education, employment, healthcare, and political participation. According to the World Bank, India's female labour force participation rate is amongst the lowest in the world. This gap has been widening over the past few decades. The International Labour Organization (ILO) also reports that women in India face a wage gap of approximately 30% compared to their male counterparts, particularly in rural areas. In terms of access to education, the Gender Parity Index (GPI) in education the gap has remarkably reduced, however the gaps remains, especially in rural and economically disadvantaged areas. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), as per the National Survey of India, the female literacy rate

in India is 70.3%, compared to 84.7% for males. Child marriage, especially in rural India, is also a contributing factor to lower educational attainment for girls. Women's representation in Indian politics is also limited. As of 2024, women accounted for only 13.6% of members in the Lok Sabha (the lower house of Parliament), far below the global average of 25%.

Similarly, India's caste system despite being constitutionally abolished continues to perpetuate significant social and economic inequalities. The country's Scheduled Castes (SCs), Scheduled Tribes (STs), and Other Backward Classes (OBCs) remain disproportionately affected by poverty, limited access to education, and low-paying employment opportunities. These groups often face discrimination in employment and have limited access to higher-paying and more stable jobs. Despite laws against untouchability, caste-based discrimination is still prevalent in many parts of the country. The National Crime Records Bureau (NCRB) reported a rise in caste-based violence in recent years, including atrocities against Dalits (SCs) and Adivasis (STs). The National Family Health Survey (NFHS-5) data from 2020-2021 indicates that the literacy rate for Scheduled Tribes is 58.5%, significantly lower than the national average of 77.7%. Furthermore, individuals from marginalized castes often face barriers in higher education, contributing to the continued cycle of poverty.

Economic inequality in India is also heavily influenced by geographic location. There is a marked disparity between the north and south, urban and rural areas, and between wealthier states like Maharashtra and Tamil Nadu and poorer states like Bihar and Uttar Pradesh. States in the southern and western parts of India, such as Kerala, Maharashtra, and Tamil Nadu, consistently outperform states in the northern and eastern regions like Uttar Pradesh, Bihar, and Madhya Pradesh on key indicators like health, education, and basic infrastructure. For example, Kerala has a 100% literacy rate, while Bihar's literacy rate hovers around 70%.

According to the Reserve Bank of India (RBI), in 2018, the average monthly household income in urban India was approximately ₹25,000, compared to ₹8,000 in rural areas. This income gap has been widening, with rural areas facing higher levels of poverty, malnutrition, and limited access to healthcare and education.

The 2011 Census of India reported that approximately 2.68% of India's population (around 26 million people) lives with some form of disability. Disabled individuals in India face significant barriers in education, employment, and social inclusion. According to a 2019 World Bank report, more than 50% of persons with disabilities in India are unemployed, and many live in poverty. Although Section 377 of the Indian Penal Code, which criminalised homosexuality, was decriminalised in 2018, there remains widespread stigma. According to a 2019 study by the United Nations Development Programme (UNDP), members of the LGBTQ+ community in India report higher rates of violence, discrimination, and mental health issues, further exacerbating their socio-economic challenges.

Social and economic inequality, particularly in the realms of gender, caste, religion, and region, presents profound challenges for India as it strives toward becoming a Viksit Bharat (Developed India) by 2047. To address these disparities effectively, a philosophical approach rooted in both Indian and Western traditions can offer valuable insights. These traditions advocate for a deeper understanding of justice, equality, and the common good, and they provide ethical frameworks for promoting a more just and inclusive society. The policies and programmes for achieving excellence in infrastructure

and widespread prosperity require being informed and sensitive towards providing equitable growth.

In this context, it is crucial to understand the philosophical framework that underpins this vision. The idea of a Viksit Bharat is informed by a blend of Indian philosophy and Western thought aiming to create a society that achieves material prosperity while ensuring social justice, environmental awareness and spiritual well-being. Indian philosophy, particularly through the teachings of Dharma, Sarvodaya, and Vasudhaiva Kutumbakam, offers frameworks for tackling social and economic inequality.

Indian Philosophical Underpinnings

Indian philosophical tradition has long emphasised collective welfare, moral responsibility, and spiritual growth. In fact at the heart of many Indian philosophical systems is the concept of Dharma, which signifies moral and ethical duty. Rooted in Hindu, Buddhist, and Jain thought, Dharma governs personal behaviour as well as societal duties. This concept not only guides personal actions but also serves as a pillar for statecraft and governance. The concept of Dharma (Righteousness and Duty), emphasises the importance of living ethically, fulfilling one's duties, and contributing to society's welfare. In the context of inequality, Dharma calls for actions that promote fairness and justice. Each person has a duty (or Svadharma) to contribute to the well-being of society based on their role and capabilities. According to the Bhagavad Gita, every individual must follow their own path of duty in alignment with the greater good of society. In modern terms, this could be interpreted as creating social structures and policies that allow individuals from marginalised communities to thrive. For instance, ensuring access to education, healthcare, and economic opportunities for women, Dalits, Adivasis, and other marginalised groups would be in line with the idea of fulfilling one's social duty. In this framework, social justice is seen as not just a policy goal, but as an essential part of the moral duty of the state, individuals, and institutions to correct inequalities. The Indian state, for instance, has enacted policies such as reservation to uplift marginalised communities, which can be seen as a manifestation of Dharma. Similarly, policies and programmes supporting inclusive affordable housing, right to ownership of housing, affordable public mobility solutions, provision of safe platform for street vendors thus enabling access to economic opportunities at all levels, provision of old age homes, rental housing for migrants in cities, women hostels, student hostels etc. need prime attention in our planning policies.

One of the central concepts to India's vision of development is "Sarvodaya" or in simple terms the "upliftment of all"as articulated by Mahatma Gandhi. This principle insists that development must prioritise the poorest and most marginalised segments of society. Gandhi's idea of development was deeply connected to moral principles of truth, non-violence (Ahimsa), and simplicity. According to this view, society should be structured in such a way that the needs and rights of the most disadvantaged are prioritised. In addressing economic inequality, the government must focus on distributive justice—ensuring that resources and opportunities are equitably distributed, especially to those who have been historically marginalised. In this view, development is not merely about material wealth but about fostering moral integrity and holistic well-being for all. Accordingly, programmes benefitting the basic needs of the impoverished and vulnerable strata of the society need to be integrated with the facilitation of economic engines charging

the growth of the nation. Our housing and infrastructure development programmes need to be driven through policies which provide shelter, economic opportunities, access to healthcare & education and quality of life for the various segments of the society.

Gandhi's approach emphasises self-sufficiency, especially in rural areas, and underscores the importance of empowerment over charity. Policies aimed at empowering marginalised groups—be it through education, healthcare, or economic reforms—align with this philosophy. As Sarvodaya promotes not just individual success but collective well-being, it emphasises that real development cannot happen until everyone in society has access to at least the basic resources. Towards our goal of realising the dream of a Viksit Bharat, equitable regional development, bringing amenities and access to our remote and impoverished areas, growth of agrarian based industrialisation while balancing it with protection of ecologically sensitive zones and tribal rights is not only a sustainable strategy for development but our moral and ethical imperative. Philosophically, the development of sustainable urban infrastructure must be grounded in the concept of Ahimsa, or non-violence, which in this context extends to reducing harm to the environment and human health. India's push for electric vehicles and clean energy reflects a commitment to protecting the environment for future generations.

The notion of Vasudhaiva Kutumbakam (the world is one family) further underscores India's approach to development. The idea of Vasudhaiva Kutumbakam, originating from the Mahopanishad, emphasises that the entire world is a unified family. This perspective encourages unity and collaboration for the common good, transcending barriers of race, religion, caste, and nationality. By applying this ancient principle to the modern context, India can approach inequality not only from a national perspective but from a global one, recognising that justice and equality should be part of a broader commitment to the well-being of humanity. It advocates for the fair treatment of all people, irrespective of gender, caste, religion, or ethnicity, and for building a society that provides opportunities for all members to flourish. In terms of practical policy, Vasudhaiva Kutumbakam suggests that India must address internal disparities in a way that recognises the inter-connectedness of all people. Social policies must not only aim for national progress but also consider global social justice, particularly the Universal Declaration of Human Rights and global poverty eradication. Rooted in the Upanishadic teachings, this idea also calls for global harmony and shared responsibility in fostering the common good particularly when it comes to managing natural resources and addressing global challenges like climate change which for a rapidly industrialising economy like ours is of utmost importance.

Western Philosophical Context

Western philosophy, particularly utilitarianism, liberalism, and egalitarianism, offers additional insights into how to address inequality which is an important hurdle to surmount in our quest for attaining a truly developed India.

The concept of utilitarianism, as advanced by philosophers like Jeremy Bentham and John Stuart Mill, provides a framework that emphasises maximising happiness and minimising suffering. This utilitarian principle aligns with India's drive to ensure that the benefits of growth are shared across all sections of society, ensuring broad-based prosperity. Affirmative action policies, which focus on uplifting marginalised communities, are a key application of this theory, as they aim to bring about a net increase in happiness by

improving the conditions of the disadvantaged. In the context of social inequality, this would translate to prioritising policies that reduce poverty, ensure equal access to healthcare and education, and promote economic growth that benefits everyone. Utilitarianism also emphasises the long-term effects of inequality on social stability. In countries with high levels of inequality, there are often negative consequences such as social unrest, economic inefficiency, and reduced social mobility. By promoting policies aimed at redistribution through mechanisms such as progressive taxation or subsidies for education and healthcare, prioritising related infrastructure where it benefits the larger masses, promoting low cost affordable technologies for achieving this goal can propel India towards the long-term well-being of society. John Stuart Mill's principle of utilitarianism aligns with the goal of sustainable urban mobility, as it seeks to create the greatest benefit for the greatest number of people. By improving transportation systems and reducing pollution, India can enhance the well-being of millions of urban dwellers, ensuring a better quality of life for all.

Furthermore, John Rawl's Theory of Justice offers a conceptual approach to structuring society so that inequality is justified only if it benefits the most disadvantaged groups. This resonates with the Indian commitment to equitable development, ensuring that India's growth does not leave anyone behind. Liberal philosophers such as John Rawls and Immanuel Kant have stressed the importance of justice and fairness in social arrangements. In his theory of justice, John Rawls advocates for the Veil of Ignorance as a way to think about social justice: policies should be designed as if one does not know which social group or identity they will belong to once the veil is lifted. According to Rawls, justice involves creating fair systems that allow all individuals to flourish, particularly the least advantaged. Redistributive justice (e.g., through progressive taxation, affirmative action) is a tool to ensure that the wealthiest segments of society do not exploit the poorest, creating a fairer society for all. In applying liberal justice to India's inequality, this philosophical approach supports policies that prioritize equal opportunities for all, regardless of caste, gender, or religion. The Indian Constitution itself embodies liberal principles by guaranteeing fundamental rights and promoting affirmative action. In India, this philosophical outlook is reflected in policies that seek to level the playing field, such as affirmative action for Scheduled Castes, Scheduled Tribes, and Other Backward Classes (OBCs), and the provision of educational opportunities for all, for instance as under the Right to Education Act.

The egalitarian (Equality of Opportunity and Outcome) view advocates for reducing social and economic disparities, not just through equality of opportunity but also through equality of outcomes. Robert Nozick, who famously critiqued redistributive justice, argued that individual rights are paramount; however, an egalitarian framework would call for policies that ensure every citizen has an equal chance to succeed. In India, this would mean providing universal access to education, healthcare, and economic opportunities for marginalised communities. It would also mean addressing institutional biases that disadvantage people based on their caste, gender, or religion.

India's commitment to economic growth and infrastructure development aligns with Karl Marx's materialist view of historical progress, where economic conditions shape societal structures. India's rapid industrialisation and infrastructure projects are seen as necessary steps to improve

the material conditions of its people, particularly the working class. However, this progress must be balanced with social justice to prevent exploitation and inequality, an idea mirrored in Marx's critique of capitalist systems.

Amartya Sen's capabilities approach, which emphasises the role of development in expanding people's freedoms and opportunities, also provides a guiding framework for ensuring that India's economic growth truly benefits all sections of society. Through digital empowerment, individuals in India are not only gaining access to information but also expanding their choices and opportunities in areas like education, employment, and healthcare.

The philosophy of Deep Ecology suggests that humans are not separate from nature but are an integral part of the ecosystem. India's approach to environmental sustainability is aligned with this view, emphasising that development should not come at the expense of the environment.

The philosophy of pragmatism, particularly as advanced by William James and John Dewey, aligns with India's approach to digital infrastructure and innovation. Pragmatism emphasises the practical consequences of ideas and policies, advocating for solutions that directly improve people's lives. By focusing on digital literacy, financial inclusion, and access to information, India's policies seek tangible outcomes that uplift millions, particularly those in rural areas.

Moreover, Albert Einstein's views on creativity and innovation suggest that true progress comes from fostering an environment where new ideas can thrive. India's push for innovation in technology aligns with this philosophy, as it provides an ecosystem that nurtures creativity, encourages risk-taking, and promotes problem-solving across various sectors.

Government's Major Schemes and Initiatives for Inclusivity

Several key government schemes reflect this vision of inclusivity. The Pradhan Mantri Awas Yojana (PMAY), aims at providing affordable housing to the urban and rural poor, directly addressing the issue of housing inequality. The scheme in its 2.0 version aims to construct 1 crore houses for urban poor and middle class families over a period of five years. Financial assistance would be extended for constructing purchasing or renting houses at affordable costs where special attention will be given to marginalised groups such as slum dwellers, SC/ST, minorities, widows, persons with disabilities, special groups like safaikarmis, street vendors, artisans, anganwadi workers and residents of slums/ chawls (Ministry of Housing and Urban Affairs). The National Rural Employment Guarantee Act (NREGA), which guarantees 100 days of wage employment to rural households, is another key initiative that contributes to inclusive development by ensuring employment for the rural poor, particularly in backward and remote areas (Government of India, 2021).

Moreover, financial inclusion has become a central goal of India's development. Initiatives like the Pradhan Mantri Jan Dhan Yojana (PMJDY), which provides access to banking services to millions of Indians, particularly the underprivileged, reflect this commitment. As of date, over 54 crore bank accounts have been opened under the scheme, facilitating direct benefit transfers (Deptt. of Financial Services, Ministry of Finance, and Government of India).

India's vision of economic growth is inherently linked to its infrastructure development. As one of the fastest-growing major economies in the world, India has made remarkable strides in expanding its industrial base, services, and trade. However, the challenges of unemployment, inflation and

income inequality persist. Addressing these issues requires continued economic reform and an emphasis on job creation, entrepreneurship, and investment in infrastructure. India's Make in India initiative is one such program designed to promote manufacturing and job creation. By enhancing the ease of doing business and improving the country's manufacturing ecosystem, the government aims to substantially increase the share of manufacturing in the GDP. Similarly, the Startup India scheme supports entrepreneurship by providing tax incentives, incubation centers, and easier access to capital for small businesses and innovators (Government of India, 2021). Another crucial area of economic focus is infrastructure development. The Bharatmala Pariyojana is a nationwide highway development program that aims to enhance road connectivity across the country. By improving road infrastructure, India hopes to reduce transportation costs, facilitate the movement of goods, and promote regional development. The Smart Cities Mission, which aims to build 100 smart cities across India, integrates advanced technologies to create urban spaces that are more efficient and livable (Ministry of Housing and Urban Affairs, 2021). The Smart Cities Mission also plays a significant role in addressing urban mobility by integrating sustainable transport solutions with advanced technologies. The development of metro networks, bus rapid transit systems (BRTS), and better pedestrian infrastructure is a key feature of this initiative.

India's urban population is rapidly growing, with over 600 million people expected to live in cities by 2031. This mass migration to cities brings with it several challenges, particularly around urban mobility—the ability to move efficiently and sustainably within urban spaces. The Indian government has recognized the need for sustainable urban transport solutions. Additionally, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) focuses on improving basic urban infrastructure such as water supply, sanitation, and transport networks, which are critical to supporting the growing urban population.

Environmental sustainability is a critical component of India's path to a developed future. India is one of the most vulnerable countries to climate change, facing challenges such as air pollution, deforestation, water scarcity, and extreme weather events. However, India has also emerged as a global leader in renewable energy and sustainable development.

India's National Action Plan on Climate Change (NAPCC) outlines the country's strategy for tackling climate change through a series of programs and policies. The Pradhan Mantri Ujjwala Yojana (PMUY), which aims to provide clean cooking gas to poor households, helps reduce indoor air pollution, which is a significant health hazard, particularly for women in rural areas (Ministry of Petroleum and Natural Gas, 2021).Additionally, India is committed to reducing its carbon footprint through the International Solar Alliance (ISA), which aims to harness solar energy as a key resource. The National Electric Mobility Mission Plan (NEMMP) and FAME India also promote electric vehicles, helping reduce the country's reliance on fossil fuels.

In the 21st century, digital infrastructure and innovation are key to driving India's future development. India has already made significant strides in digital transformation through initiatives like Digital India, which aims to provide internet access and digital services to every citizen. The Pradhan Mantri Gramin Digital Saksh Yojana (PMGDISHA) is an initiative aimed at providing

digital literacy to rural citizens, empowering them with the skills needed to access government services, online education, and financial services. As of 2021, the program had already reached over 6 crore individuals, enabling millions to become active participants in the digital economy (Ministry of Electronics and Information Technology, 2021).

India's Startup India program has also been pivotal in fostering innovation, providing financial and policy support for budding entrepreneurs. With the rise of fintech, healthtech, and agritech, India's startup ecosystem has emerged as one of the most dynamic globally, with over 1,28,000 recognized startups as of April 2024 (Startup India Success Data Report 2024).

The National Digital Communications Policy (NDCP) 2018 has set the ambitious goal of achieving broadband for all and enhancing connectivity through improved telecom infrastructure. The government's investment in 5G technology and internet penetration in rural areas is crucial for bridging the digital divide and ensuring that digital infrastructure reaches every corner of the country.

Conclusion

India's vision of a Viksit Bharat 2047 is an ambitious and multidimensional endeavour. It is not just about achieving economic growth but also about ensuring that this growth is inclusive, equitable, and sustainable. The government schemes and initiatives including Make in India, Pradhan Mantri Awas Yojana, Startup India, Smart Cities Mission, and FAME India, represent the country's strategic focus on addressing the challenges of poverty, unemployment, environmental degradation, and infrastructure gaps. India's path to a Viksit Bharat is undoubtedly complex and strewn with challenges, but the nation's resilience, its young population, and its philosophical and cultural wisdom provide a strong foundation for the journey ahead. By continuing to focus on inclusive growth, sustainability, innovation, and technological advancement, India can indeed achieve its vision of becoming a developed nation by 2047—a nation that stands as a model for others in balancing economic progress with social justice, environmental stewardship, and human well-being.

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THE INTERSECTION OF ECONOMIC GROWTH AND ENVIRONMENTAL SUSTAINABILITY IN INDIA: PATHWAYS FOR VIKSIT BHARAT

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The paper examines India's economic growth and its alignment with environmental sustainability, it explores "Green Growth" initiatives, including the Union Budget's INR 350 billion investment in net-zero emissions and energy security, along with India's commitment to SDG 11 (Sustainable Cities) and SDG 13 (Climate Action) through programs like the Smart Cities Mission and PMAY.

It further discusses the impact of rapid urbanisation, with 40% of the population projected to live in cities by 2030, contributing 70% to GDP. The paper addresses infrastructure challenges, a $840 billion investment requirement by 2036, and limited private sector involvement. Environmental concerns such as urban sprawl, carbon emissions, and water scarcity are analysed, alongside strategies for sustainable housing, energy-efficient construction, and renewable energy adoption.

Finally, the paper highlights the roles of government, private sector, and civil society in promoting sustainable urban housing. It emphasizes public-private partnerships, community engagement, and innovative financing models. The Paper advocates for integrated policies, smart city development, and circular economy practices to ensure balanced economic growth and environmental resilience, positioning India as a leader in sustainable urbanisation by 2047.

1. Background

1.1 Introduction: Overview of Economic Development and Environmental Sustainability

India, a mixed economy with a GDP of approximately $3.5 trillion in 2024, is a land of diversity and rich cultural heritage. India's vision to become a "developed" economy by 2047, termed as the 'Amrit Kaal' has gained significant momentum. Despite global challenges such as the pandemic and economic crises, India has risen from the 13th position to become the fifth largest economy in the world, growing at an average rate of over 6%. India is one of the few nations experiencing rapid economic growth while also focusing on sustainable development.

- **Green Growth and Sustainable Development**

"Green growth" refers to the promotion of economic expansion while ensuring natural resources continue to provide crucial environmental protection This growth has been fuelled by economic liberalisation, market orientation, and increased private capital, positioning India for sustained and robust growth in the coming years.

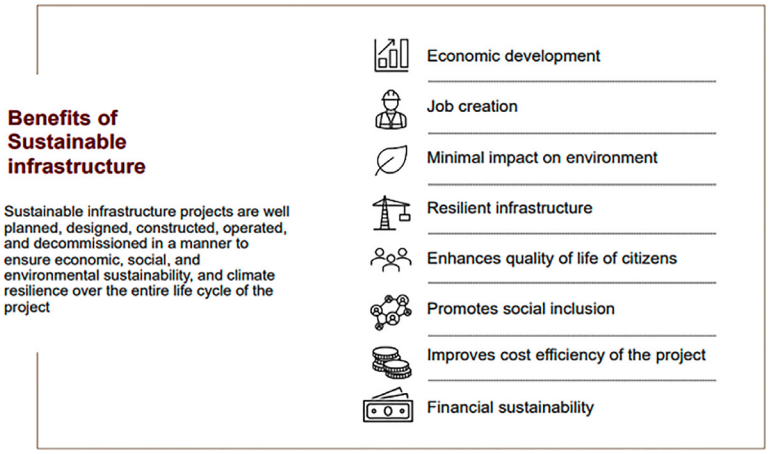


Figure 1 Benefits of Sustainable infrastructure

- Newly-introduced initiatives in the Union Budget for greening the system, under the 'Green Growth' priority, and recent announcements, including INR 350 billion of priority capital investments directed to the net zero transition and energy security, can help India pursue – its sustained economic growth and expansion.
- The development of both urban and rural areas to ensure overall national progress. By 2030, it is projected that 40% of India's population will reside in urban areas, contributing significantly to the country's GDP. However, rapid urbanisation poses challenges in managing infrastructure and delivering services effectively.

India's urban development is closely tied to the Sustainable Development Goals, particularly:

- SDG 11: Sustainable Cities and Communities aims to make cities inclusive, safe, resilient, and sustainable. India's efforts through PMAY and the Smart Cities Mission are direct contributions to achieving SDG 11, aiming to enhance the quality of urban housing and infrastructure while ensuring accessibility for all.
- SDG 13: Climate Action involves taking urgent action to combat climate change and its impacts. Urban housing contributes to this through the adoption of sustainable construction practices and the integration of renewable energy sources which reduce the carbon footprint of urban centre's.

1.2 Urbanisation and Infrastructure Development

By 2030, it is projected that 40% of India's population will reside in urban areas, contributing significantly to the country's GDP. However, rapid urbanisation poses challenges in managing infrastructure and delivering services effectively.

The Smart Cities Mission is a key initiative aimed at addressing these challenges efficiently. As of February 2024, 6,753 projects out of a total of 7,991 have been completed under the Smart Cities Mission, showcasing tangible progress. Moreover, India has made significant strides in digital infrastructure development, with rural areas expected to contribute significantly to new internet user growth, with around 56% of total new internet users coming from rural India by 2025, according to a report by TransUnion CIBIL. This trend underscores the increasing connectivity between rural and urban regions in the country.

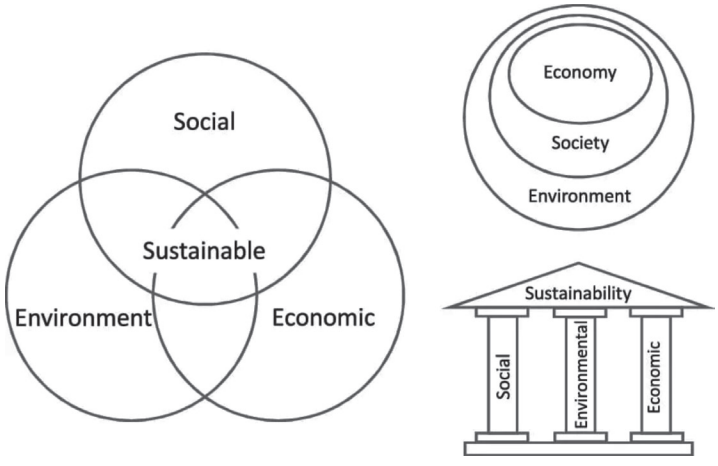
India is urbanising rapidly. By 2036, its towns and cities will be home to 600 million people, or 40 percent of the population, up from 31 percent in 2011, with urban areas contributing almost 70 percent to GDP by 2036. India will need to invest $840 billion in infrastructure - an average of $55 billion or 1.2 percent of GDP per annum. However, estimates suggest that between 2011 and 2018, the country's total capital expenditure on urban infrastructure averaged only 0.6 percent of GDP, which is half of the required quantum of investment. Central and state governments finance 72 percent of urban infrastructure, with commercial financing providing only 5 percent. Recognising these challenges, the government has taken measures to enable commercial financing, but its use remains extremely limited, even in financially strong cities. To tap into private capital, urban local bodies (ULB) will need to comprehensively build their capacity and focus on executing bankable projects. It will also be important for the country to develop the municipal bond market and introduce innovative financing structures.

- **Financing Challenges in Infrastructure Development:** Despite a substantial increase in public investment—central government spending has more than doubled from FY21 to FY24—private capital remains largely untapped. Institutional investors, like insurance and pension funds, allocate only 6% of their funds to infrastructure.The long gestation periods and high capital requirements of infrastructure projects deter traditional lenders, exacerbating the financing gap. To achieve its ambitious infrastructure goals, India needs greater private sector involvement. Without it, the country's grand vision may fall short.

1.3 Environmental Challenges and Rapid Urbanisation

The expansion of urban areas contributes to increased greenhouse gas emissions and ecological footprint, complicating efforts to address climate change. Cities like Delhi, Bengaluru, Chennai, and Hyderabad are particularly vulnerable, facing threats like zero groundwater levels and high risks of flooding. The situation is exacerbated by inadequate provision of basic urban services, which has been compounded by climate change impacts. Despite these challenges, there are significant strides towards improving urban housing and infrastructure. Infrastructure development, especially in transit systems like metro and rapid rail, are also notable, enhancing urban connectivity and reducing emissions.

The relationship between economic growth and environmental sustainability in India has been widely explored, revealing a delicate balance between development and ecological preservation. Research indicates that India's rapid economic expansion



has often come at a significant environmental cost, with industrialisation and fossil fuel combustion contributing to severe pollution and health risks. Studies highlight that urban air pollution, inadequate water supply, poor sanitation, and indoor air pollution impose substantial social and financial burdens, further exacerbating environmental challenges. The Environmental Kuznets Curve (EKC) hypothesis, which suggests that environmental degradation initially rises with economic growth but declines after reaching a certain income threshold, has been applied to India. However, empirical findings remain mixed, suggesting that while economic growth may eventually lead to better environmental outcomes, this transition is neither automatic nor guaranteed. Additionally, recent research has delved into how sectors such as agriculture, energy use, and trade influence environmental sustainability, emphasising the complexity of this relationship. Overall, the literature underscores the need for policies that integrate environmental considerations into economic development strategies, ensuring that India's progress aligns with the principles of sustainability and the achievement of Sustainable Development Goals (SDGs).

2. Scale and Scope of Urbanisation and Housing Developments

India is undergoing rapid urbanisation, a trend projected to contribute significantly to its economic growth. According to the United Nations, India's urban population is expected to reach 675 million by 2035, up from about 461 million in 2021. This massive urban migration has fuelled extensive urban housing development. Mega cities like Mumbai, Delhi, Bengaluru, and Hyderabad have expanded exponentially, with both government and private sectors pushing large-scale residential projects. These development aim to meet the growing need but also reflect the increasing preference for urban lifestyles. However, the pace of housing development varies significantly across the country, with metropolitan areas witnessing much more construction activity.

2.1 Demographic and Economic Factors Driving Urban Housing Demand

The demand for urban housing in India is indeed influenced by a combination of demographic and economic factors, which can be illustrated with more detailed, current facts and trends:

- **Population Growth and Urban Migration:** India is one of the most populous countries in the world, with its population exceeding 1.3 billion. The urban population is expected to rise significantly, with estimates suggesting that by 2050, nearly 50% of India's population will reside in urban areas. This shift is largely driven by the search for better employment opportunities, which urban centres predominantly offer. For example, cities like Bangalore, Mumbai, and Delhi attract thousands of young professionals annually, especially from the tech, finance, and services sectors, thus propelling the demand for housing in these areas.
- **Income Growth:** Economic expansion has led to the growth of India's middle class, which the World Economic Forum notes has been one of the fastest-growing in the Asia-Pacific region. The increase in disposable income among this group has enabled more Indians to invest in property, not just as a necessity but also as an asset for wealth accumulation. This trend is supported by easier access to financing, such as low-interest home loans and

government subsidies for first-time homebuyers.

- **Socioeconomic Changes:** The cultural trend towards nuclear families is another significant driver. The traditional extended family living arrangement is becoming less common as more young adults and couples opt for privacy and independence. This shift is reflected in the rising demand for 1-2 bedroom apartments in urban and suburban areas, rather than the large multi-generational homes that were previously common.
- **Real Estate as an Investment:** Despite fluctuations in the economy, real estate in India remains a favoured investment. The stability seen in real estate, especially in contrast to the volatility of the stock market, makes it hugely attractive. Additionally, the real estate market has seen a compounded annual growth rate (CAGR) of approximately 22% over the past decade, underscoring its potential as a lucrative investment. This is further buoyed by tax incentives on property investments and the potential rental income, which is highly appealing to both domestic and NRI (Non-Resident Indian) investors.

2.2 Challenges posed by current urban housing policies and practices

The challenges in urban housing policies and practices in India are multifaceted, affecting a broad spectrum of the population and reflecting deeper systemic issues. Below is a detailed analysis of these challenges, incorporating recent data and additional challenges:

- **Affordability Crisis:** The affordability of housing remains a critical issue in urban India. According to the 2021 Knight Frank Affordability Index, housing affordability in key Indian cities like Mumbai, Delhi, and Bengaluru has deteriorated over the last decade. For instance, in Mumbai, the average citizen would need to spend about 10 years' worth of the average annual income to afford a home, making it one of the least affordable housing markets globally. This stark affordability gap drives the proliferation of slums, which are estimated to house approximately 65 million people or 17% of India's urban population, according to a 2019 report by the Ministry of Housing and Urban Affairs.
- **Regulatory Hurdles:** Regulatory challenges significantly impede housing development. A World Bank report highlights that India ranks 163rd in terms of ease of obtaining construction permits, taking an average of about 94 days to complete the procedures, considerably higher than many other countries. These delays, exacerbated by bureaucratic inefficiencies and land acquisition disputes, can significantly drive up project costs and timelines, further impacting affordability and supply.
- **Quality of Urban Infrastructure:** Urban infrastructure development has not kept pace with the rapid construction of housing units. A 2020 NITI Aayog report states that only 70% of urban households have access to piped water, and vast disparities in sewage and waste management systems exist. Power outages remain frequent, and road congestion is common in cities, undermining the quality of urban living and limiting the effective integration of new housing development into the existing urban fabric.
- **Environmental Concerns:** Rapid urban construction

often flouts environmental norms. For instance, in many expanding urban areas, wetlands and green spaces are being converted into residential zones without adequate environmental assessment, leading to issues like reduced biodiversity, increased urban heat, and exacerbated air pollution. The Carbon Disclosure Project (2021) found that over 70% of Indian cities do not have a robust action plan to tackle urban emissions, despite the growing acknowledgment of the need to incorporate climate resilience into planning processes.

- **Speculation and Over-Supply:** The real estate market often sees speculative investment, particularly in the luxury segment, which leads to an imbalance in the housing supply. As per a report by Anarock Property Consultants, as of late 2021, the unsold inventory of luxury homes (priced above INR 1.5 crores) across the top seven cities was over 35,000 units, contrasted with acute shortages in affordable housing segments.

Additional Challenges

- **Inclusive Development:** There is a lack of policies that effectively integrate lower-income groups into the urban housing market, often segregating these populations into less desirable city zones.
- **Technological Adoption:** The slow adoption of modern construction technologies hampers the ability to build quickly and cost-effectively.
- **Financial Constraints:** The financial health of the real estate sector has been shaky, with many developers facing liquidity issues affecting ongoing and planned projects.

3. Environmental Impacts of Urban Housing

- **Assessment of the carbon footprint from urban housing sector:** Urban housing significantly contributes to India's greenhouse gas (GHG) emissions. The residential sector accounts for approximately 22% of the nation's total annual carbon emissions. This substantial share underscores the need for energy-efficient practices and sustainable building materials in urban housing. The disparity in carbon footprint among different income groups is notable. High-expenditure households emit nearly seven times more carbon compared to low-income households. This variation is attributed to factors such as larger living spaces, higher energy consumption, and greater use of carbon-intensive appliances in affluent households.To mitigate these emissions, adopting energy-efficient technologies is essential. Implementing such measures not only helps in reducing carbon footprint but also aligns with India's climate goals, including commitments under the Paris Agreement and the country's target to achieve net-zero emissions by 2070.

3.1 Key Energy-Efficient Technologies for Reducing Urban Housing Emissions in India

A. Green Building Materials and Sustainable Construction Practices

- Using low-carbon construction materials such as fly ash bricks, bamboo, and recycled steel can significantly cut down emissions.
- Precast concrete technology reduces on-site waste and minimises energy consumption.
- Cool roofs and reflective paints help in lowering indoor temperatures, thereby reducing the need for air conditioning.

B. Energy-Efficient Building Designs

- Passive solar design optimises natural light and ventilation, reducing dependency on artificial lighting and air conditioning.
- High-performance glass windows and double-glazed windows enhance insulation, keeping homes cooler in summers and warmer in winters.
- Green roofs and vertical gardens provide insulation while improving air quality.

C. Adoption of Renewable Energy Sources

- Solar rooftop panels can power homes with clean energy, reducing reliance on fossil fuels.
- Net metering policies enable households to sell excess solar energy back to the grid, encouraging wider adoption.
- Solar water heaters significantly reduce electricity consumption in residential buildings.

D. Smart and Energy-Efficient Appliances

- LED lighting consumes up to 80% less energy compared to traditional incandescent bulbs.
- Bureau of Energy Efficiency (BEE) star-rated appliances, including air conditioners, refrigerators, and fans, help in minimising energy use.
- Smart home automation systems optimise electricity use by automating lighting, temperature control, and appliance operations.

E. Efficient HVAC (Heating, Ventilation, and Air Conditioning) Systems

- Inverter technology in ACs reduces electricity consumption by adjusting cooling based on room temperature.
- Geothermal heating and cooling systems use underground heat for temperature regulation, reducing dependency on conventional power sources.
- Energy Recovery Ventilators (ERVs) help maintain indoor air quality while saving energy.

F. Water and Waste Management Solutions

- Rainwater harvesting systems reduce dependence on municipal water supplies and lower energy consumption related to water pumping.
- Greywater recycling enables the reuse of water from sinks, showers, and washing machines for non-drinking purposes.
- Waste-to-energy solutions, such as biogas plants and composting, reduce landfill emissions.

4. Innovative Practices for Sustainable Urban Housing

4.1 Case studies of sustainable urban housing projects in India: The following are few notable domestic and global case studies exemplifying innovative practices in sustainable urban housing (Table no. 1).

5. Role of the government, private sector, and civil society in promoting sustainable urban housing

In India, the promotion of sustainable urban housing necessitates a collaborative approach involving the government, private sector, and civil society. The government plays a pivotal role by formulating policies and frameworks that encourage sustainable practices. Initiatives like the Pradhan Mantri Awas Yojana (PMAY) aim to provide affordable housing while integrating eco-friendly technologies and materials. The Smart Cities Mission further underscores the commitment to sustainable urban development by focusing on efficient resource management and green infrastructure.

The private sector contributes significantly through innovation and investment in sustainable building technologies. By adopting green certifications and energy-efficient designs, private developers not only enhance environmental sustainability but also meet the growing consumer demand for eco-friendly living spaces. Public-private partnerships (PPPs) have emerged as effective mechanisms in this realm, leveraging private expertise and capital to bolster public initiatives. For instance, PPPs have been instrumental in advancing sustainable building projects in developing countries, effectively mobilising resources and expertise.

Civil society organisations (CSOs) play a crucial role in bridging the gap between policy and community needs. By advocating for marginalised groups and facilitating community participation, CSOs ensure that housing projects are both inclusive and sustainable. In Kerala, for example, the Kudumbashree initiative has empowered women through participatory housing schemes, demonstrating the potential of community-driven development.

Community engagement is integral to the success of sustainable urban development. When communities are actively involved in the planning and implementation of housing projects, the outcomes are more likely to be equitable and resilient. Research indicates that projects prioritizing community engagement not only strengthen social cohesion but also contribute to more sustainable urban environments.

Public-private partnerships have proven effective in achieving sustainable outcomes by combining the strengths of both sectors. These collaborations facilitate resource mobilisation, risk-sharing, and the integration of innovative solutions. In India, PPPs have been pivotal in developing urban infrastructure that aligns with sustainability goals. For example, the Smart Cities Mission leverages PPPs to enhance urban infrastructure, aiming to uplift citizens' quality of life and foster sustainable urban development.

To move towards a **sustainable yet economically robust future,** the following solutions outlined in (Table no. 2) can be implemented.

6. Way Ahead

India's 2047 infrastructure vision encapsulates a transformative agenda aimed at harmonising economic growth with environmental sustainability, leveraging comprehensive strategies across multiple dimensions of urban development. The Production Possibility Frontier (PPF) framework elucidates the necessary trade-offs and identifies potential solutions that can sustain this balance. For urban planners, this framework presents a dynamic toolkit for strategic decision-making, advocating for integrated policies that reinforce urban resilience and sustainability. Future urban planners will be pivotal in implementing initiatives like PM Gati Shakti, which coordinates infrastructure projects across various sectors, and the Smart Cities Mission, which integrates innovative technologies to enhance urban life quality. Additionally, the push towards renewable energy, illustrated by the Green Hydrogen Mission, and substantial investment channels through the National Infrastructure Pipeline signals a shift towards sustainable urban ecosystems. These initiatives not only require urban planners to adeptly manage technological and financial resources but also to drive regulatory reforms that support sustainable development. By focusing on these areas, urban planners will play a crucial role in shaping India into a global leader in sustainable, inclusive, and climate-resilient urban growth, setting benchmarks for infrastructure that can adapt to both current needs and future challenges.

Table No.: 1

Domestic Case Studies	*Global Case Studies*
➢ **Tata Housing Development Company's Sustainable Projects:** Tata Housing Development Company, a subsidiary of Tata Sons, has been a pioneer in integrating sustainability into urban housing. Since its revival in 2006, the company has focused on developing green buildings across various Indian cities. A notable example is the Xylem project in Bengaluru, recognized as the city's first sustainable IT park, which received a gold certification from the Leadership in Energy and Environmental Design (LEED). This project set a precedent for future developments, ensuring that all subsequent projects, from affordable housing to luxury residences, adhere to sustainable green standards certified by the Indian Green Building Council (IGBC)	➢ **Stockholm Wood City, Sweden:** Planned in the Stockholm neighborhood of Sickla, Stockholm Wood City is set to become the world's largest wooden-built urban area, covering 25 blocks and 250,000 square meters. Key features include: ▪ Sustainable Construction: Utilizing timber, which significantly reduces CO_2 emissions during construction and maintenance. ▪ Mixed-Use Development: Housing 7,000 office spaces, 2,000 homes, along with retailers and restaurants to create a vibrant community. ▪ Health Benefits: Studies suggest wooden buildings can improve air quality, reduce stress, and increase productivity.
➢ **Volontariat Homes for Homeless Children, Pondicherry:** Designed by architect Anupama Kundoo, the **Volontariat Homes for Homeless Children** in Pondicherry exemplify sustainable and inclusive housing. This project utilized innovative building techniques, such as those pioneered by Ray Meeker of Golden Bridge Pottery, to create eco-friendly and cost-effective homes. The design focuses on circular economy principles, locally sourced materials, and clean construction approaches, providing valuable insights into planning and designing inclusive housing that addresses environmental concerns.	➢ **Masdar City, Abu Dhabi, UAE:** Initiated in 2006, Masdar City is a planned urban development aiming to be a hub for clean technology and sustainable living: ▪ Renewable Energy: Powered by solar energy and designed to be carbon-neutral. ▪ Passive Design: Buildings are oriented and constructed to maximize natural ventilation and minimize heat gain. ▪ Transportation: Prioritizing pedestrian and cyclist movement with a reduced reliance on automobiles. As of 2020, the city continues to develop, serving as a model for sustainable urban planning.

- **Bhendi Bazaar Redevelopment Project, Mumbai:**

  Initiated by the Saifee Burhani Upliftment Trust (SBUT), the Bhendi Bazaar Redevelopment Project aims to transform a 16.5-acre area comprising over 250 decrepit buildings into a sustainable urban space. The project focuses on:

  Environmental Sustainability: Incorporating sewage treatment plants, central garbage disposal systems, rainwater harvesting, green spaces, and solar lighting to promote eco-friendly living.

  Improved Infrastructure: Widening narrow lanes into 60-foot-wide roads and providing ample parking facilities to enhance mobility and reduce congestion.

  Community Welfare: Ensuring that each legitimate tenant transitions from cramped accommodations to modern apartments with improved amenities.

  As of early 2020, the first phase, Al Sa'adah Towers, was completed, housing 610 families and 128 businesses. Improved Infrastructure: Widening narrow lanes into 60-foot-wide roads and providing ample parking facilities to enhance mobility and reduce congestion.

  Community Welfare: Ensuring that each legitimate tenant transitions from cramped accommodations to modern apartments with improved amenities.

  As of early 2020, the first phase, Al Sa'adah Towers, was completed, housing 610 families and 128 businesses

- **BedZED (Beddington Zero Energy Development), UK:**

  Completed in 2002, BedZED is the UK's first large-scale, mixed-use sustainable community:

  - Energy Efficiency: Homes are designed to use zero net energy, incorporating solar panels and high insulation.
  - Water Conservation: Features such as rainwater harvesting and low-flow fixtures reduce water usage.
  - Community Engagement: Designed to promote social interaction and a strong sense of community among residents.

Table No.: 2

Identified Issues	*Proposed Solutions*	*Details*	*Examples / Case Studies*
Trade-offs in Efficient ResourceAllocation	1. Enhancing Smart City Infrastructure	☑ **Integrate IoT & AI for smart urban planning –** IoT-powered waste management, traffic control, and energy-efficient buildings optimize resource. allocation. ☑ **Expand metro & EV infrastructure –** Expanding metro systems and electric vehicles (EVs) reduces pollution and congestion. ☑ **Mandate green building projects (LEED-certified) –** Sustainability benchmarks ensure long-term environmental balance	☑ **Singapore Smart Nation –** AI-powered urban development integrates IoT for sustainability. Singapore's Smart Nation Initiative has increased efficiency in waste management by 30% using AI-powered systems. × India's urban population is expected to grow by 416 million by 2050, making sustainable planning crucial. × Delhi Metro has reduced CO_2 emissions by 6.3 million tonnes annually due to fewer cars on roads. ☑ **Delhi Metro Rail Corporation (DMRC) –** Reduces vehicular load, improves sustainability. × Expanding metro connectivity can reduce peak traffic congestion by 40% in metro cities. ☑ **India's GRIHA** × **Certification –** Encourages eco-friendly construction. India's 100 GW solar capacity goal represents a 25% share of total energy production by 2030. • Sweden generates nearly 50% of its energy from waste-to-energy plants.

Inefficient Utilization of Resources × Poor urban planning, wasted resources	2. Improving Resource Utilization & Urban Planning	☑ **Upgrade urban planning policies** – Proactive policies ensure balance between commercial and green spaces. ☑ **Strengthen Public-Private Partnerships (PPP) –** Tax incentives and subsidies attract private investment in green infrastructure. ☑ **Promote circular economy** – Waste-to-energy, recycling, and rainwater harvesting reduce resource wastage	× **Curitiba, Brazil** – Transit-oriented development supports sustainability. × **India's TULIP Internship Program** – Trains young professionals in sustainable urban planning. **Sweden's Waste-to-Energy Plants** – Converts waste into renewable energy.
× Unattainable Goals × Need for innovation & policy expansion	3. Expanding the Production Possibility Frontier(PPF) Through Innovation	☑ **Invest in renewable energy** – Solar and wind power expansion reduces fossil fuel dependency. ☑ **Implement stricter environmental regulations** – Carbon pricing and emissions control policies encourage sustainable practices. ☑ **Leverage international collaborations** – Global partnerships provide funding and technology support for green initiatives.	× **India's National Solar Mission –** Aims to install 100 GW of solar capacity by 2030. × **European Union Carbon Pricing Mechanism –** Reduces carbon emissions by penalizing polluters. × **Paris Agreement** – Global effort to combat climate change through policy cooperation.

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Mumbai Trans Harbour Link (MTHL)

The 21.8 km Mumbai Trans Harbour Link (MTHL or Atal Setu) is an operational 6 lane access-controlled sea bridge with a route alignment connecting Sewri in Mumbai with Chirle in Navi Mumbai, Maharashtra. On the Sewri-end, a three-level interchange connects it to the under construction Sewri-Worli Elevated Corridor and Eastern Freeway. On the Navi Mumbai-end, the bridge has an interchange each at Shivaji Nagar and Chirle. The MTHL Link provides a faster connectivity with proposed Navi Mumbai International Airport, Jawaharlal Nehru Port (JNPT), Mumbai – Pune Expressway and Mumbai – Goa Highway.

The concrete bridge features a 4 km steel span section in the middle to allow for ships to pass underneath. The longest span of MTHL is 180m and the shortest is 100m long. MTHL's lanes have a width of 3.5 meters with a 2.5 meter wide shoulder on either side and 0.75m shoulder at the median. The maximum speed limit on the Trans Harbour Link is restricted to 100 kmph.

MTHL is equipped with an Intelligence Transport System (ITS) and other amenities required for a marine bridge. The traffic conditions on the stretch are monitored and managed from a traffic control centre with the help of CCTV cameras and related facilities installed on the stretch. Variable Message Signs (VMS) have been installed to display appropriate information for the bridge users.

The Trans Harbour Link is also provided with noise barriers near Sewri mud flat area and view barriers at Bhabha Atomic Research Centre (BARC) to address the environmental concerns.

BRIDGING THE DIVIDE: STRENGTHENING SOCIAL INFRASTRUCTURE FOR THE URBAN POOR

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Ensuring that the benefits of India's urbanisation and economic development are accessible to all—especially marginalised and vulnerable populations—is a crucial aspect of the Sustainable Development Goal 11 and the New Urban Agenda. Recognising the deep linkage of urban poverty with infrastructure and services like housing, healthcare and education, this article focuses on the role of social infrastructure in alleviating the social and economic vulnerabilities of the urban poor and breaking the vicious cycle of poverty. Drawing on the current policy directions of the Ministry of Housing and Urban Affairs, the article explores possible strategies for the sustainable development of essential social infrastructure like homeless shelters, crèches, labour chowks, vending zones, etc. Further, it outlines planning provisions, operations and maintenance strategies and financial sustainability models to make such infrastructure sustainable and responsive; and provides illustrative examples to inspire localised action.

Introduction

Indian cities are rapidly emerging as hubs of economic growth, innovation, and cultural exchange, driving the nation's development. Ensuring that the benefits of this progress reach all segments of society, particularly marginalised and vulnerable groups, is key to the realisation of the Sustainable Development Goals and the New Urban Agenda.

The Indian labour market is predominantly informal, with around 90% of the workforce engaged in precarious and unregulated jobs. In urban areas, informal workers provide critical services like construction, waste picking and sorting, street vending and domestic work, but find themselves relegated to the fringes of society. This became painfully evident during the COVID-19 pandemic, when authorities realised that mandatory stay-at-home policies were un-implementable for those who relied on daily wages for economic survival and used substandard shared amenities to meet basic human needs.

Urban poverty is closely tied to limited access to quality housing, basic services,

healthcare, and education. Poor infrastructure exacerbates the socio-economic challenges faced by the urban poor, trapping them in cycles of poverty. In Indian cities, it is not uncommon for the working poor, including many migrants, to live on footpaths or rely on homeless shelters for housing and depend heavily on public sanitation facilities and community canteens for their basic needs. Construction workers and labourers in transportation and logistics frequently congregate in unregulated areas in search of daily wage employment. Women providing care to affluent households in the form of domestic help or childcare often leave their children without adequate care when they are working. Improving quality and access to infrastructure is not only supportive of the livelihoods of the urban poor but also essential to help them endure harsh conditions, including exposure to extreme weather, exploitation, and health risks.

Informal sector workers experience multiple deprivations, including infrastructural deficiencies, due to their residential, occupational, social, and economic vulnerabilities. Unable to afford market-provided infrastructure, they depend on public provision, and particularly rely on community networks and social capital for access. In any society, social infrastructure, which includes soft and hard infrastructure around services and processes that respond to community needs and enhance their social capacities, plays an important role in upholding quality of life, equity, law and order, stability and social well-being. Without targeted investments in social infrastructure, urban areas risk deepening inequalities, exacerbating poverty, and stalling socio-economic mobility, particularly for the urban poor.

In this article, we highlight how the development of adequate and inventive social infrastructure can contribute to crucial aspects of the Government of India's existing policy measures towards inclusive urbanisation, including the following:

(i) The acknowledgement of a crucial unorganised workforce through registration, both through national databases like the E-Shram and through state- and scheme-specific modalities;

(ii) Improved access to basic amenities and services like water, sanitation and energy; and

(iii) The provision of social protection and safety nets including pensions, food assistance, subsidies etc.

However, cities face enormous challenges such as land scarcity, resource mismanagement, operational inefficiencies, and funding constraints in producing and managing social infrastructure. We argue that creative and collaborative approaches are the need of the hour, so that communities of the working urban poor are equal participants and beneficiaries of 'Viksit Bharat Vision 2047', which aims to establish India as a $32 trillion economy.

Past and Emerging Responses

In alignment with its guiding philosophy of "Sarvodaya se Antyodaya tak" (from welfare for all to the upliftment of the last person), India is dedicated to addressing the challenges faced by its urban poor. Through initiatives such as the National Urban Livelihoods Mission (NULM), the government is making significant progress in enhancing infrastructure and services for marginalized urban communities, with the goal of breaking the cycle of multidimensional poverty. In the first phase of NULM, over 1,950 Shelters for Urban Homeless (SUH) have been established, accounting for 80% of the total shelter space created. These shelters are

designed to meet diverse needs, including general shelters (which make up more than three-quarters), as well as shelters for men, women, families, and special groups, reflecting a wide distribution.

Progressive state policies have allowed regions like Rajasthan and Tamil Nadu to develop a significant number of SUHs, while cities such as Surat have created large-capacity shelters to accommodate large migrant populations. In cities like Kanpur and Kochi, SUHs have played an essential role in promoting economic empowerment by providing access to PM SVANidhi loans, skill training, and other resources. In Delhi and Aurangabad, shelters are also offering educational support to young residents, while in Vadodara and Kolkata, shelter occupants are being integrated into government schemes such as Aadhar, Poshan, PAN, and ration cards. The success of the SUH component of NULM showcases the transformative potential of social infrastructure in addressing the vulnerabilities faced by informal workers.

Over a decade of these interventions have demonstrated the importance of enhancing social infrastructure to address specific occupational needs and broader vulnerabilities of informal workers. Some ideas include setting up City Livelihoods Centres (CLC), well-equipped Labour Chowks for daily wage workers (particularly construction workers), and improved care infrastructure.

The CLCs are envisaged as one-stop hubs for informal workers, providing spaces to market their products and services, access essential information, and avail of various government services. Labour chowks will revamp existing labour congregation areas into dedicated spaces where workers can access basic amenities and find job opportunities. They can also vital points for disseminating vital information about rights and government welfare schemes, and availing services like registration and grievance redressal. Building care clusters in close proximity to urban poor households that offer bundled services around multigenerational care and early childhood education can significantly unburden the lives of women from low-income households, freeing their time for remunerative work. The collaborative efforts of various stakeholders will be crucial to developing these social infrastructures on ground.

Global and Indian Good Practices

There are several good practices, both from India and around the world, that can be adapted, replicated, and scaled according to the local context. For instance, Bogotá's "Care Block" initiative addresses the additional burden of home care, which often heightens the vulnerability of neglected women. The program centralises key services for female caregivers, improving their well-being and reducing the time spent on unpaid tasks. Bogotá has established Care Blocks and Care Buses to bring essential infrastructure and services to support women caregivers and their families in both urban and rural areas.

In Indonesia, community-run childcare centres called Taman Penitipan Anak (TPA) support working parents, particularly mothers. Established in 2001 by the Directorate of Early Childhood Education, these centres provide services for children aged 0–6 years. Located near workplaces like plantations, markets, and factories, TPAs serve both formal and informal economy workers across all income levels. They operate 8–10 hours daily, primarily run by local foundations, self-help groups, companies, and private entrepreneurs.[1] Learnings drawn from such examples would provide insight in developing centres

[1] https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@gender/documents/genericdocument/wcms_737555.pdf

focused on intergenerational care, particularly for women in the informal workforce.

Further, the city of Lagos is planning 104 community recycling centres that will also act as information centres with a focus on women and youth empowerment. The city intends to place two centres per local council development area and up to 20 jobs will be created per centre.[2] This highlights the need to understand the local context and needs by adopting an evidence-based and participatory approach while implementing intervention at the city livelihood centres.

Figure 2. Kadiya Naka, Ahmedabad (Ahmedabad Municipal Corporation)

In India, improved labour chowks are already functional in several cities. For example, Kadiya Naka in Ahmedabad and Shehari Nirman Chowk in Noida feature designs that provide shaded seating spaces, access to sanitation, and drinking facilities for daily wage labourers. Government investment in creating more such spaces can play a pivotal role in developing cities that meet the needs of informal sector workers.

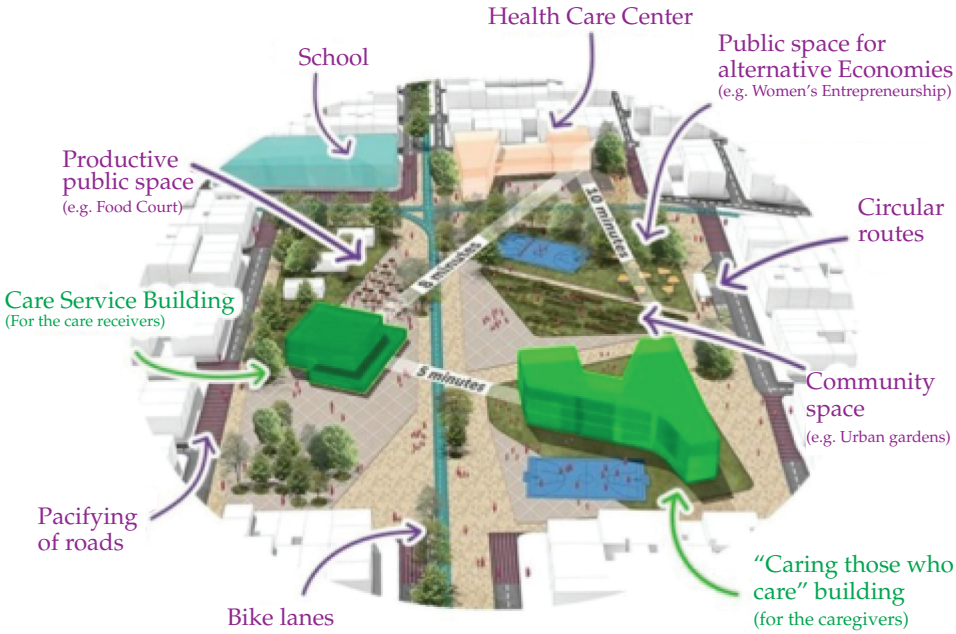

Figure 1. Care Block, Bogota (https://oecd-opsi.org/blog/bogota-cares/)

Barriers and Challenges

The development and management of social infrastructure for informal sector workers is hindered by various barriers. These include land scarcity, resource mismanagement, operational inefficiencies, funding limitations, and social barriers. Some of the key challenges are outlined below:

Land Availability: In rapidly growing cities across India, particularly in metropolitan and hill cities, land has become an increasingly scarce and precious resource. Given this limitation, carving out land in appropriate locations for the development of essential social infrastructure, such as shelters, livelihood centres, and public amenities, is very difficult and often costly, creating an additional obstacle to the expansion of vital infrastructure.

[1] https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@gender/documents/genericdocument/wcms_737555.pdf

Resource Mismanagement: The efficient allocation and management of resources, both financial and physical, is a major challenge. Many urban development or social welfare programs face issues with misallocation or poor management of resources. Without adequate data or proper estimates supporting the demand for specific infrastructure, these projects often get deprioritised, leading to inefficient use of available resources.

Operational Inefficiencies: Bureaucratic delays, lack of coordination between government departments, and inefficient policy implementation slow progress and hinder the success of social infrastructure projects. Furthermore, when infrastructure is poorly maintained or lacks sufficient operational support, services deteriorate over time, reducing their effectiveness.

Low importance in policy and planning frameworks: Policies aimed at supporting informal workers is usually focused on welfare and not planning as well as often lack clarity, consistency, and coherence. Additionally, frequent changes in policies can disrupt long-term planning and cause delays in project implementation. The absence of integrated development plans that incorporate social infrastructure into larger urban planning frameworks further complicates the identification of optimal locations for these essential facilities.

Funding Constraints: Social infrastructure projects are capital-intensive and require substantial long-term investment, not only for their initial development but also for ongoing operations and maintenance. Government programs often face budgetary constraints that limit the ability to adequately fund and maintain critical infrastructure such as shelters, care centres, and livelihood support facilities.

Social and Cultural Barriers: Informal workers, often marginalised or stigmatised, face difficulties in accessing services specifically designed to meet their needs. Gender disparities, especially in care giving and domestic work, further exacerbate the challenges, with women in the informal sector facing even greater barriers to accessing support services and social infrastructure. Social and cultural factors like caste, class and ethnicity present significant challenges in integrating informal workers into urban development initiatives.

Opportunities and Recommendations

Given the myriad challenges, there is a pressing need for a comprehensive and integrated approach to social infrastructure. Such an approach must redefine social infrastructure to cater to the diverse needs of informal workers while optimising land and resource use. This requires effective urban planning, robust operations and maintenance frameworks, financial sustainability models, and equitable distribution of infrastructure across communities. In this context, a "4-Cs" strategy is proposed, which includes the following elements:

1. Contextual Infrastructure Planning

A set of clear standards and guidelines for city officials and urban planners would go a long way in realising robust and adequate social infrastructure in Indian cities. Currently, the Urban and Regional Development Plan Formulation and Implementation (URDPFI) Guidelines only acknowledge night shelters (or shelters for the urban homeless) and suggests providing a maximum of 1,000 sqm, subject to availability of land for every 10-lakh population. As per the Assam State Livelihood Mission, the establishment of 8 City Livelihood Centres will be permissible for population more than 10 lakhs[3]. Guidelines for other desirable social infrastructure facilities

[3] https://dohua.assam.gov.in/portlet-innerpage/city-livelihoods-centreclc

labour chowks and care centres for informal sector workers, currently absent, could be good starting points.

However, to ensure that social infrastructure is optimally positioned to serve local communities, it is essential to identify key areas that maximize both accessibility and impact. Success depends on a thorough understanding of the specific infrastructure required and a strategic selection of its location, based on a comprehensive evaluation of the local context. This includes assessing demographic, socio-economic, and cultural characteristics, as well as existing infrastructure, local needs, and potential for future growth.

However, the lack of standards and guidelines to identify the location and distribution of social infrastructure hinders the ability of local governments to take these factors into account. Such demand-based planning could be achieved by adopting a participatory approach through involving the local communities and informal worker groups, and through the use of digital technologies.

2. Capitalize on Existing Infrastructure

Revitalizing and reimagining the use of existing social and community infrastructure—such as social welfare hubs, community canteens (e.g., Amma Canteen, Indira Canteen), public sanitation facilities, and community toilets—is vital for creating a more coordinated and efficient system. For example, a labour chowk could be strategically placed near public toilets and community kitchens, improving access for informal workers to critical services and facilities. This would enhance the utility of existing infrastructure and improve the overall well-being of the workforce. Such hub and spoke approach would optimise the use of existing investments and infrastructure.

3. Coordinated Infrastructure Delivery

Maximising the efficient use of land and developing social infrastructure in an integrated manner is crucial. Infrastructure should be designed to serve multiple functions and purposes, either by utilising the space at different times or by allocating specific floor areas for different uses. For instance, a public toilet, community learning centre and social welfare hub could be located on different floors of the same building. Additionally, a large hall and play area in a labour chowk, designed with an open layout, could function as a day care centre for children during the daytime when workers are away. This would require visualising social infrastructure from a comprehensive and holistic viewpoint.

4. Convergence in Service delivery & Operations

Sustaining the success of social infrastructure requires effective and consistent operations, maintenance, and service delivery mechanisms. These can be enhanced by leveraging community potential and strengthening existing safety nets. For example, local self-help groups, community interest groups, and area-level federations can actively participate in the management and upkeep of these facilities. Moreover, aligning these projects with central and state government schemes and exploring Corporate Social Responsibility (CSR) funding can ensure the sustainability of operations. To further improve service delivery, user feedback systems should be implemented to make responsive adjustments based on the evolving needs of the community.

Way Forward

Prioritising social infrastructure is a reliable pathway for cities to become inclusive and equitable. This calls for urban stakeholders to keep an additional 3-Cs - Community, Creativity and Collaboration - at the heart

of their urban development approaches.

The citywide implementation of social infrastructure appears daunting, but can be simplified by borrowing a page out of the popular "15-minute city approach", which places the community at the centre and imbibes equity and inclusivity as core principles. The approach can be used to prioritise underserved areas, design streets and transport systems that cater to the needs of vulnerable workers and identify appropriate avenues for developing public spaces and social infrastructure for socialising, rest and interaction, while supporting informal workers at the neighbourhood scale.

Cities must adopt a creative playbook, drawing on tactical urbanism to leverage localised and, at times, even temporary opportunities, to demonstrate the positive effects of social infrastructure and thereby generate longer-term demand for such interventions.

Finally, enabling varied stakeholders to work together is crucial. Social infrastructure offers the rare opportunity for urban local bodies, private landowners, community-owned enterprises, CSR foundations, technical experts and investors to collaboratively create public goods that enhance the possibility of creating sustainable livelihoods and delivering a higher quality of life for those at the bottom of the pyramid.

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Delhi Mumbai Industrial Corridor

The Delhi-Mumbai Industrial Corridor (DMIC) is an ambitious infrastructure project aimed at creating a world class industrial zone along a 1,504-km stretch between Delhi, the national capital and Mumbai, India's financial hub. Spanning six states – Uttar Pradesh, Delhi NCR, Haryana, Rajasthan, Gujarat, and Maharashtra- the project is designed to enhance industrial growth, foster urbanisation, and position India as global manufacturing hub. With an estimated investment of USD 100 billion, the DMIC, is one of the largest infrastructure projects in the world, promising to reshape India's economic landscape.

The project spans a corridor of 150-200 km on both sides of the Western Dedicated Freight Corridor (DFC), a high-speed rail network that facilitates efficient movement of goods DFC, covering a total area of approximately 436,000 square kilometers. This region accounts for nearly 14% of India's land area and contributes a significant portion of the country's industrial output. The DMIC aims to double employment, triple industrial output, and quadruple exports in the region.

The corridor encompasses several key components, including nine mega industrial zones, high- speed freight lines, three new ports, six greenfield airports, and a six lane expressway connecting Delhi and Mumbai. These infrastructure projects are complimented by smart cities with integrated townships and state-of-the-art utilities, including a 4,000 MW power plant and water supply systems to meet the demands of industrial and residential developments.

One of the defining features of DMIC is its emphasis on sustainability through incorporation of green initiatives such as energy efficient buildings, solar power plants rainwater harvesting systems and environmental conservation. The economic impact of DMIC is expected to be immense. The project aims to generate over three million jobs during its construction and operational phases significantly boosting employment in the region. The corridor's enhanced connectivity and logistics infrastructure will reduce transportation costs, making Indian goods more competitive in the global markets.

MOVING TOWARDS A CIRCULAR ECONOMY IN INDIA AND THE REGION

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India is amongst the fast growing countries in the Asia-Pacific region and has experienced rapid urbanisation and improved living standards over the past few decades. India is actively transitioning to a circular economy, focusing on closed-loop systems, resource efficiency, and sustainable practices, with initiatives like the Circular Economy Cell in NITI Aayog and policies promoting waste management and recycling.

Key Initiatives and Policies:

- Circular Economy Cell (CE Cell) in NITI Aayog: This dedicated unit within NITI Aayog works on developing a comprehensive mission document, interactive dashboard, and furthering engagement with states on circular economy initiatives.
- Swachh Bharat Mission (SBM-U): This mission strengthens urban waste management with a focus on 3R principles (Reduce, Reuse, Recycle).
- GOBARdhan Scheme: This scheme promotes waste-to-wealth initiatives through biogas and organic waste processing.
- E-Waste Management Rules (2022):These rules strengthen circular economy practices in electronic waste disposal.
- Extended Producer Responsibility (EPR) for Plastic:This encourages industries to take accountability for plastic waste.
- India's G-20 Presidency Focus: During its G-20 presidency, India prioritised resource efficiency and circular economy, focusing on areas like circularity in the steel sector, Extended Producer Responsibility (EPR), circular bioeconomy, and establishing an industry-led resource efficiency and circular economy industry coalition.
- 7Rs of Circular Economy: The government advocates for the 7Rs of circular economy: Reduce, Reuse, Recycle, Redesign, Remanufacture, Refurbish, and Repair.

Benefits and Potential:

- Economic Growth: A circular economy can lead to significant economic benefits, with studies predicting potential annual benefits of USD 624 billion by 2050.
- Job Creation: The circular economy is expected to create millions of jobs.
- Environmental Conservation: By minimising waste and resource extraction, a circular economy can contribute to environmental conservation and sustainability.
- Resource Efficiency: The circular economy aims to maximise the value of resources throughout their lifecycle, promoting resource efficiency.
- Sustainable Development: Transitioning to a circular economy aligns with the Sustainable Development Goals (SDGs).

Challenges and Opportunities:

- Infrastructure Development: Improving infrastructure for waste management and recycling is crucial.
- Awareness and Education:
- Creating awareness and education programs about circular economy practices is essential.
- Incentives and Policies: Providing incentives for circular economy practices and developing supportive policies are necessary.

Research and Development:

- Promoting research and development in the field of circular economy can lead to innovative solutions.
- Collaboration: Between government, businesses, and civil society is essential to build a robust circular economy framework.
- Startups: India has a growing number of startups focused on circular economy solutions, indicating the potential for innovation and growth in this sector.

Resource Efficiency Circular Economy Industry Coalition (RECEIC)

Circular economy, extended producer responsibility and resource efficiency plays a critical role by making an endeavour to decouple our economic growth from environmental degradation and enhancing sustainable consumption and production, including primary resource consumption while supporting economic growth and achieving sustainable development. During the Indian presidency of G-20, an industry led coalition on Resource Efficiency Circular Economy Industry Coalition (RECEIC) was launched by committing to enhance environmentally sound waste management, substantially reduce waste generation by 2030, and highlighting the importance of zero waste initiatives.

RECEIC has the potential to transform aspirations into concrete action and would play a pivotal role in promoting alliances, encouraging technological cooperation and knowledge transfer, fostering innovation, and facilitating the exchange of insights to enhance access to finance.

The RECEIC, conceptualised by the India's G20 Presidency is envisaged to be industry driven and a self-sustaining initiative continuing to function even beyond India's G20 Presidency. The mission of this coalition is to facilitate and foster greater company-to-company collaboration, build advanced capabilities across sectors and value chains, bring learnings from diverse and global experiences of the coalition members, and unlock on-ground private sector action to enhance resource efficiency and accelerate circular economy transition.

The coalition is structured around the three guiding pillars of partnerships for impact, technology cooperation and finance for scale. Resource efficiency and circular economy

industry coalition will also aim to contribute towards progress on key global goals and priorities set by the G20 and other international foram. RECEIC will also act as an overarching platform enabling industries to address information gaps and coordination challenges across the G20 members.

India's tryst with a circular economy

The mission includes initiatives to promote waste segregation, recycling, and composting, and aims to make India a "zero-waste" country.

These developments, however, have led to increased material extraction, consumption, and waste generation, exacerbating global environmental challenges such as biodiversity loss and pollution. The linear "take-make-waste" economic model that dominates the region is unsustainable, with countries breaching critical planetary boundaries. A shift to a circular economy, which aims to decouple economic growth from environmental degradation, offers a solution by promoting systems where materials are used efficiently with limited waste, and nature is regenerated. The circular economy presents a transformative approach for Asia-Pacific countries, many of which have expressed a growing interest in such strategies. Despite this interest, widespread action is yet to arise. Without bold, ambitious measures, the circular economy risks becoming just another concept, and the region may miss out on the opportunity to balance economic development with environmental sustainability.

Moving from a Linear to a Circular Economy is a philosophy of 3R from 'Take, Make, Use & Waste" to Take, Make, Use & Recycle (including Repair & Reuse thus regenerating value)".

- Focus on how India can deal with waste at different stages
- Developed India of 2047 includes a landfill-free India
- Maximising Resource Efficiency & Promoting Sustainability in a circular form
- Mission Life – a mantra for sustainable development to the world - to reach in a mission form to around 80%of the villages
- Every household to have access to renewable energy – GoI Schemes such as PM-KUSUM, PM-Surya Ghar, Go Electric campaign etc.
- Cities Coalition for Circularity (3-C) – Adopting Circularity Principles to reduce India's Carbon footprint.
- Enhancing Recycling rates for critical materials with ambitious goals for Plastics, E-Waste and C&D Waste

Key Drivers of Circular Economy Implementation

Businesses in the Asia-Pacific region, from micro,small and medium enterprises (MSMEs) to large multinational corporations, play a pivotal role in driving circular economy activities. These businesses are uniquely positioned to integrate circular principles into their supply chains and offer circular solutions. However, governments must create enabling environments to support and accelerate these activities. There are six key drivers for unlocking the circular economy across the region:

1. Infrastructure: Adequate digital and physical infrastructure is necessary to support circular activities such as waste separation, recycling, and resource recovery. Digital platforms can facilitate the exchange of recyclable materials, while physical systems for waste management, like those seen in China and the Republic of Korea, can significantly enhance recycling rates.
2. Regulation: Effective regulatory frame works

can incentivise businesses to adopt circular practices. For example, Japan and the Republic of Korea have implemented Extended Producer Responsibility (EPR) systems that hold manufacturers accountable for their products entire lifecycle, including post-consumer waste management. These regulations encourage businesses to design products with recyclability in mind and promote the use of recycled materials.

3. Education: Education and capacity building are critical for equipping the workforce with the skills needed to support circular economy activities. Programs such as Toyota's employee training on sustainable practices are essential for fostering a circular mindset.
4. Finance: Financial instruments, including public and private funding, are vital to scaling up circular economy initiatives. Companies like Nestle and Indorama Ventures have benefited from green financing frameworks and blue loans, enabling them to invest in practices such as recycling infrastructure and renewable energy production.
5. Innovation: Innovation is at the core of advancing the circular economy. Companies in the region have pioneered new business models, such as Vietnam's Glassia Water, which offers bottled water as a service using refillable glass bottles. Additionally, regenerative agriculture initiatives in China exemplify how innovative practices can contribute to circularity.
6. Collaboration: Collaborative efforts between governments, businesses, and other stakeholders are crucial for scaling up circular solutions. Industrial symbiosis, as seen in Japan's Kitakyushu Eco-town project, demonstrates how businesses can collaborate to turn waste from one entity into resources for another, maximising resource efficiency and reducing environmental impacts.

Policy Landscape and Maturity

Governments in the Asia-Pacific region have made varying levels of progress in developing circular economy policies. Japan, the Republic of Korea,and China are at the forefront, with comprehensive policies already implemented, such as Japan's Circular Economy Vision 2020 and the Republic of Korea's EPR framework. However, many other countries are still in the early stages of policy development, with some formulating roadmaps and calls to action.

UN-ESCAP's report titled "The secrets to unlocking the next frontier for a circular economy in the Asia-Pacific region" identifies various policies across the region, each at different stages of maturity, from early stage frameworks to fully implemented policies through enacting laws, regulations, and/or economic or fiscal incentives. These policies cover critical areas such as waste management, recycling, and resource efficiency. Policy development and implementation lessons learned include:

1. Trade policies need to align with circular economy goals to avoid negative spillovers and support global sustainability efforts.
2. The success of new circular economy policies also relies on the effective enforcement of existing waste management and other related environmental regulations.
3. Society needs to be engaged to embrace shifts in consumption patterns and ensure their success. This is crucial when implementing circular economy policies. A significant obstacle is the frequent focus

on waste management without equal emphasis on reducing waste at its source.

Business Initiatives in Circularity

Several businesses in the Asia-Pacific region have already taken significant steps toward implementing circular economy principles with and without government support. These businesses include Budweiser Brewing Company Asia-Pacific Limited; City Developments Limited; CLP Holdings; En+Group; Indorama Ventures; Mahindra Group; and Unilever PLC. These examples highlight the potential for businesses to lead the circular economy transition. However, scaling these efforts across the region requires more robust government support and policy alignment. Key implementation challenges are high initial investment and upfront cost; supply chain and operational challenges; and ambiguity in definitions and requirements; consumer behavior and market demand; and limited capacity of organisations to implement and adopt circular economy policies.

The Next Frontier for Circular Economy in the Asia-Pacific Region

To fully unlock the potential of the circular economy, countries in the Asia-Pacific region must move beyond awareness and take decisive action. Governments need to implement and enforce policies that incentivise circular practices, while businesses must continue to innovate and collaborate.

The next frontier for circularity in the region will be characterised by a level playing field where products and services are developed by circularity competitive in the market and over time linear practices are phased out. With the right infrastructure, regulations, education, financial support, innovation, and collaboration, the Asia-Pacific region can lead the global transition toward a sustainable, circular economy that benefits both society and the planet.

India's First Hyeperloop: Delhi-Jaipur

The Indian Institute of Technology (IIT) Madras has developed India's first hyperloop test track, spanning 422 meters. This state-of-the-art facility, developed with support from the Ministry of Railways and L&T Constructions aims to propel India into the next era of high-speed transportation. The hyperloop system envisions transporting passengers in pods through low-pressure tubes at speeds exceeding 1,000 km/h, potentially reducing travel time between Delhi and Jaipur to a mere 30 minutes.

The Hyperloop is a high-speed transportation system designed for long-distance travel. It is often dubbed the "fifth mode of transport" alongside road, rail, air, and water. The technology utilises customised capsules or pods that are driven at extraordinary speeds through near-vacuum tubes. The vision of the hyperloop is to reach speeds that are comparable to or even higher than those of flights by significantly lowering air resistance and friction. In full-scale systems, the pods in hyperloops are said to be able to reach speeds of up to 1,200 kilometres per hour. The track for Hyperloop can be built either above or below ground. Unlike trains or cars that have wheels, the pods are developed to float on air skis, or use magnetic levitation (maglev) technology to lower friction. Hyperloop is marked by its immunity to weather, collision-free commute which can move at twice the speed of a plane, with low power consumption and energy storage for 24-hour operations.

The successful implementation of hyperloop technology could revolutionise India's transportation infrastructure, offering ultra-fast, efficient, and sustainable travel option. This advancement not only promises to enhance connectivity between major urban centres but also positions India at the forefront of innovative transportation solutions on the global stage.

Looking ahead, there are ambitious plans to extend this technology to create a hyperloop corridor between Chennai and Bengaluru, potentially covering the 350 km distance in just 15 minutes.

SORASORI MUKHYAMANTRI: BUILDING PUBLIC TRUST

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The present paper explores implementation and impact of the grievance redressal initiatives under the Chief Minister's Office (CMO) in West Bengal, India. Launched in 2019 and revamped in 2023 as Sorasori Mukhyamantri (SSM), the project integrates advanced Information and Communication Technologies (ICT), including artificial intelligence (AI) and real-time data processing, to improve public service delivery through prompt grievance resolution processes. It enables citizens to voice their grievances directly to the highest levels of government and works to foster transparency and accountability of the administration to ensure inclusive governance at the grassroots. With over 4.6 million grievances addressed and 75% of them resolved, the project demonstrates how technology may be leveraged to ensure a people-centric governance. The paper highlights the methodology, results, replicability, sustainability, and alignment with Sustainable Development Goals (SDGs), offering insights for national and global replication.

1. Introduction

Trust in government institutions is essential to foster citizen engagement and ensure effective delivery of public services. West Bengal, with a projected population of 103 million in 2024, is India's fourth-most populous and thirteenth-largest state by area. Despite having a well-established framework for people-oriented welfare schemes, delivering efficient public services has remained a challenge in this densely populated state. State Government departments have been trying to address citizens' concerns by establishing grievance-redressal mechanisms, but without a coordinating system, people are faced with little options but to navigate multiple offices and bear substantial costs to have their complaints addressed. Thus, while wealthier individuals can afford to expedite their concerns, the poor, illiterate, and marginalised communities may be left without support, facing denial of services. Prior to the operationalisation of the present grievance-redressal

mechanism, there has been little that could boast of a standardised approach to handling of grievances, little service-level monitoring, and a dearth of technology and data-driven analysis to improve service delivery. As a result, valuable grievance data that could inform policy changes has often been lost.

In order to address these challenges, the Grievance Redressal Project was launched in June 2019 to establish a responsive, accountable, and transparent public service delivery system. The initiative sought to move beyond conventional grievance disposal approaches by identifying gaps in the implementation of welfare schemes and introducing significant policy interventions. Building on the success of this system, the West Bengal government introduced the "Sorasori Mukhyamantri" (SSM) initiative in June 2023 as an extension of the grievance redressal mechanism. This initiative includes a Call Centre Unit, a Data Processing Unit, and a Field Validation Unit, allowing citizens to raise concerns directly with the highest authority in the state via phone calls, social media, emails, letters, and the Apon Bangla portal for overseas residents. By leveraging digital infrastructure and real-time data insights, the government aims to ensure swift, equitable, and transparent grievance resolution.

Beyond redressal, "Sorasori Mukhyamantri" has played a crucial role in shaping policy interventions and fostering an inclusive eco-system. The initiative has gained recognition for its scalable grievance-handling framework, which integrates seamlessly with existing administrative networks, facilitating real-time information flow. In the process, the system, by identifying lapses or delays, has ensured swift corrective action and improved service delivery. The system also extends door-to-door services, reaching citizens directly and addressing their concerns in a timely manner.

Within just eighteen months of its launch, the SSM initiative has impacted over 6.1 million people. Emergency grievances are addressed within 2-24 hours, individual benefit-related complaints are resolved within seven days, and community issues such as road repairs or sanitation are tackled on a medium-term basis. The system also manages grievances requiring policy-level interventions. A unique feature of the initiative is its integrated on-site verification process, wherein field executives gather real-time feedback from beneficiaries, helping refine policies and enhance implementation strategies.

The Monitoring of Programme Implementation and Grievance Cell, under the aegis of the Office of the Hon'ble Chief Minister, West Bengal serves as a central hub, working in synergy with flagship schemes like BSKs and Duare Sarkar to bring government services closer to the people. The governance model has strengthened public trust and encouraged people's participation through continuous engagement with state officials.

2. Technological Framework

The system leverages several advanced ICT tools, including:

- **GIS Mapping and Dynamic Dashboards** for real-time data visualisation.
- **AI Integration** for automated grievance classification, emergency grievance identification, and Action Taken Report (ATR) verification.
- **API Integration** with other state government portals such as Jai Bangla, BSK, and the Social Security Portal for seamless data sharing.
- **Grievance Tracking Mechanism** with SMS updates and real-time tracking for transparency.

2.1 Stakeholder Engagement

The project involves over 4,500 administrative units and multiple departments. A dedicated Call Centre, Data Processing Unit, Field Validation Unit, and a social media cell ensure that grievances are handled efficiently. Field teams verify resolutions on the ground and upload citizen feedback to the SSM's social media handles, building public trust and accountability.

All grievances received through toll-free no. **9137091370** at Call Centre are uploaded and routed through the portal (www.cmo.wb.gov.in) for taking further necessary action.

The existing set up of the CMO Grievance Cell along with the Managerial and Data Analysts dedicated for CRMU have been streamlined to ensure:

- Real-time data collection.
- Result-based monitoring of data.
- Understanding the profile of the applicants.
- Validation and sanitization of data received.
- Real-time assessment, escalation and resolution of grievance data.
- Timely update on redressal status to stakeholders through SMS.
- Citizen Satisfaction Survey.
- Outreach surveys through outbound calls
- Finding out policy and implementation level gaps, preparing analytical reports to be shared with Departmental Heads.

The call centre has been equipped with the required ICT infrastructure for smooth operations including network infrastructure, hardware infrastructure and telecom infrastructure as given below:

- Network Infrastructure: The call centre is equipped with properly laid out LAN infrastructure and other network equipment (such as routers, switches, firewalls etc.) along with required internet connectivity for connecting to required sites/applications of the MPI&GC for integration /access purpose as required by Information Technology & Electronics Department.
- Hardware & Software Infrastructure: Like Servers, SAN storage, PCs, the software operating system, application servers, web servers, database servers, load balancers, CRM, CTI, TTS, ACD, Dialler, voice logger, IVRS for call waiting, active directory, antivirus & other security solutions etc.
- The system architecture has been designed to meet the requirements of the programme and the performance including service levels.
- Telecom Infrastructure and codes.

Table 1: Call Centre Unit & Data Processing Unit

Sl No	Role Description	No. of Personnel
1	Team Lead (Tele Calling)	40
2	Tele-callers	420
3	Quality Lead (Tele Calling)	40
4	Total Manpower	500

420 tele-callers are available to take calls from citizens who collect in detail information like applicants' profile, address, grievance description and submit for validation. The team-lead, with around 3-5 years of experience in handling tele-callers, are present at the call centre floor to oversee the day-to-day operations. The quality-lead reads the grievances, modifies when necessary to ensure that the correct grievance description is noted for effective redressal and maps a grievance category for each

grievance lodged. They have access to all call recording for reference. On an average 40 tele-callers are mapped to each quality-lead.

Sl No	Role Description	No. of Personnel
1	Principal Manager	1
2	Senior Manager	5
3	Assistant Manager	5
4	Data Analyst	40
5	Operational Analyst	10
6	Total Manpower	61

3. Results and Achievements

3.1 Quantitative Outcomes

Since its inception, the project has processed over **4.6 million grievances,** with a 75% resolution rate. Key achievements include:

- **Emergency Response:** 1,000 emergency grievances resolved within 2–24 hours.
- **Policy Impact:** The system's data-driven insights have contributed to initiatives such as Duare Sarkar (Government at Doorstep), Paray Samadhan (Community Problem Resolution), and Pathashree (Road Construction/Repair).
- **Social Security:** Enabled 3.2 million pensions and facilitated financial aid for 22 million women under the Lakshmir Bhandar scheme. The Grievance Redressal Cell has received over 4.6 million grievances and all these grievances are addressed by the state government departments. The standard procedure for grievance redressal includes lodging of grievance, categorisation of the grievances as per the grievance description allied as per the department concerned and then it is sent to respective department for redressal from the Chief Minister's office Grievance Redressal Cell.

The department takes necessary action and informs the complainant about the action taken. The Action Taken report is submitted to the Chief Minister's Office through the CMO Grievance portal and hence, the complainant is verified through verification call and field validation unit and then the grievance is redressed. The details of the grievances received and redressed are shown in figure 1 and 2.

3.2 Qualitative Impact

- **Inclusivity and Gender Equality:** 45% of grievances were raised by women, and 67% originated from rural areas, reflecting the platform's accessibility and broad reach.
- **Support for Vulnerable Communities:** The system facilitated food and shelter for 4 million people during the

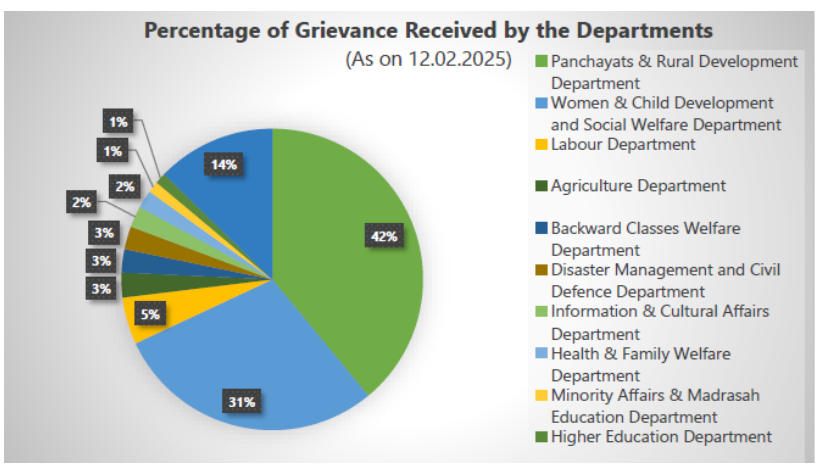

Figure 1: Grievances lodged by the citizens of West Bengal (Distributed Department Wise)

COVID-19 pandemic and provided travel assistance to 2 million migrants.

- **Healthcare and Education:** Over 90,000 families received better healthcare facilities, and 50,000 students secured financial aid for higher education through proactive intervention.

governance, the system can be scaled and adapted to urban, rural, and disaster-prone areas in both developing and developed nations.

4.1 Crisis Management

Disaster Resilience: This feature is particularly relevant in disaster-prone regions, where rapid response and effective resource distribution are critical. The grievance system can be replicated in areas frequently affected by natural disasters. During COVID-19 pandemic, the grievances handled through the portal helped the state government to reach out to nearly 4 million people for providing food and shelter and another 2 million migrants with travel assistance proving it's resilience in crisis. During Super Cyclone 'Amphan' (on May, 2020), this portal handled more than 30,000 grievances pertaining to house damages, requirement of food and emergency medicines.

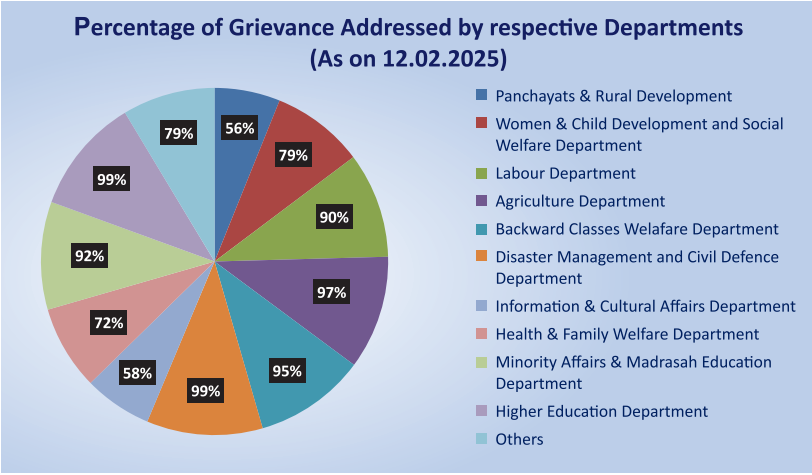

Figure 2: Grievances addressed by respective Departments as per grievances received (Reference Figure 1)

4. Replicability and Scalability

The project has already been replicated by various governments as well as other Departments handling specific grievances such as "Paribesh App (https://shorturl.at/omdBz)" which handles grievances related to Environment only. By leveraging technology, promoting inclusivity, and utilising data-driven

4.2 Transparency and Accountability:

Attributes like grievance id, name of the complainant, contact number of the complainant, grievance lodge date, and complainant's address are used to identify and verify grievances. In the database table for grievance description, the system generated grievance id acts as the primary key which is further used to identify all the details of a grievance. The grievance monitoring platform also has a grievance tracking mechanism, through which one can track a grievance using a combination of the attributes. Further, system triggered SMS updates ensures transparency. The details like complainant name, phone number and address are useful for the executing offices or field level offices for verification of the grievances. The audit logs like time, duration etc. of users are also tracked into the user log events. This audit trails are used for identification and verification of user activity, ensuring compliance with set regulations, troubleshooting system issues, providing legal evidence etc. This feature is easily transferable to other regions that struggle with government responsiveness, as it enhances citizen

engagement and strengthens democratic governance.

4.3 Replicability in Developing Countries:

- **Similar Governance Challenges:** The issues of inefficiency, corruption, and lack of access to services are prevalent in many developing countries. The structure and approach of this grievance redressal system is replicable in countries facing similar challenges.
- **Inclusive Service Delivery:** The system's focus on marginalised communities, women, and rural populations aligns with the goals of many developing countries that aim to improve governance for their most vulnerable population. Implementing a centralised, transparent grievance system can promote greater inclusivity and equality in service delivery. Third Party audit of the project undertaken by Pratichi (India) Trust, in June 2021 testifies that about 2 per cent of the people belonging to Scheduled Tribes have accessed the services of this project, followed by 17 per cent of Scheduled Castes and 28 per cent of Other Backward Communities, reflecting a fair amount of diversity in participation across the spectrum of citizenship of the State. Further, 45 per cent of the grievances come from women and 63 per cent of grievances are from the adult members of the family. It endorses the project's acceptance and trust of people.

4.4 Policy and Data driven Governance Implications

The initiative has influenced several policy changes, including the enhancement of social security scheme- Lakshmir Bhander and recruitment process adjustments. Real-time data collection and analysis enable policymakers to address implementation gaps and create targeted welfare programs.

The portal enabled the government in taking informed decisions in conceiving various State schemes/ micro-schemes like Duare Sarkar (Government at door step), Paray Samadhan (community problem resolution), Duare Ration (Public Distribution System at doorstep), 'Pathashree' (construction/ repairing of roads), Sneher Paras (Special assistance for stranded migrants during COVID 19 lockdown), Karma Bhumi (portal to collaborate between Job Seekers and Employers in IT/ ITeS sector aftermath of COVID 19 lockdown).

4.5 Contribution to Sustainable Development Goals (SDGs)

1. SDG 1 - No Poverty:

The project has played a crucial role in poverty alleviation by ensuring direct financial support through social security schemes. Over 1.1 million beneficiaries received assistance under Pension scheme for old aged, widow and physically challenged through direct intervention of the project and has facilitated over 3.2 million old aged and physically challenged for bringing them under the pension scheme. Additionally, more than 0.11 million women benefitted from the Lakshmir Bhandar scheme due to direct intervention through the grievance redressal system and 22 million women has been facilitated in getting the benefit, reinforcing economic security for low-income families.

2. SDG 2 - Zero Hunger:

The initiative strengthened food security efforts by ensuring 49k beneficiary families has received subsidised food grains under Khadya Sathi and by facilitating 3.3 million people in obtaining digital ration card ensuring access to essential nutrition for vulnerable populations.

3. SDG 3 - Good Health and Well-being:

Healthcare accessibility improved significantly, with 45k individuals benefitting from Swasthya Sathi (Health Assistance Card), 55k receiving financial support for medical expenses and hospitalisation, particularly for economically weaker sections. The project has facilitated over 90k families in getting better health care facilities through the health care schemes and government hospital services. Additionally, it has resolved around 0.8k grievances of the health care providers in providing smooth health services.

4. SDG 4 - Quality Education:

Timely interventions of 50k students ensured that all eligible students received financial aid under the Swami Vivekananda Scholarship for Higher Education in the field of Science, Arts, Commerce, Technology, Professional degrees etc, Aikyashree Scholarship and Medhashree. Many students who were previously excluded due to documentation/ credentials errors or bank-related issues successfully secured their entitlements, ensuring uninterrupted education for marginalised communities.

5. SDG 5 - Gender Equality:

Women's economic empowerment received a boost, with 0.8k beneficiaries under Rupashree (Marriage assistance) and 15k under Lakshmir Bhandar (universal monthly assistance to women aged between 25 years to 60 years), strengthening financial security for women-led households. Additionally, 0.6k female students benefitted from the Kanyashree scholarship program through the grievance redressal system and has received their rightful benefits through proactive intervention.

6. SDG 6 - Clean Water and Sanitation:

Under the Nirmal Bangla (Rural Sanitation) initiative, 13k households gained access to improved sanitation facilities, 24k grievances has been redressed promoting hygiene, health, and dignity.

7. SDG 9 - Industry, Innovation, and Infrastructure:

Around 15 million grievances have been addressed related to Industry, Road Connectivity and Infrastructure, and innovation. Under the Pathashree scheme 12k kilometres road has been constructed / repaired.

8. SDG10-Reduced Inequality:

The portal has played a key role in financial inclusion by ensuring marginalised communities, including 62k beneficiaries of Jai Bangla/ Taposali Bandhu Pension (pension to Scheduled Tribes/ Scheduled Castes and Other Backward community), received their entitled support, promoting equitable access to welfare services and reducing socio-economic disparities. The grievance redressal system ensures that all citizens, including marginalised groups, have equal access to government services. By addressing grievances and ensuring equitable service delivery, the system helps reduce social inequalities and promotes fairness in governance.

9. SDG 16 - Peace, Justice, and Strong Institutions:

The portal promotes transparency, accountability, and access to justice. By providing citizens with a direct channel to resolve issues strengthens the trust between the government and the people, which contribute to stronger institutions and fosters peace and justice.

4.6 Case Studies

Case Study 1: Urgent Need for a baby's Life-Saving Surgery

The Crisis:

Sek Hazrat Ali (Name Changed), a concerned citizen from Bagnan-I, Howrah, faced a heart-wrenching

situation involving his five-month-old baby, Kaniz Kulsum. On 7th June 2023, the baby was diagnosed with a heart blockage, leading to critical complications. Seeking medical help, the citizen visited Bagnan Hospital and Uluberiya Mohokuma Hospital, both of which recommended immediate surgery. As the baby's condition deteriorated, she was admitted to the ICU at PG Hospital. The ICU at PG Hospital became their last hope. However, PG Hospital lacked the necessary facilities for the required open-heart surgery in his desperate plea to Hon'ble Chief Minister, the citizen implored the concerned authority to arrange a bed in any hospital capable of providing the essential treatment without delay.

Intervention and Resolution:

Upon receiving Sek Hazrat Ali's grievance, the Chief Minister's grievance cell promptly intervened in the matter. The case was immediately taken up with the relevant authorities and medical professionals. After consultation with the Cardiothoracic and Vascular Surgery (CTVS) team, it was determined that the baby falls under the Sishu Sathi scheme (State Government Health Scheme for Children) and awaits approval for a referral to Narayana Hospital for the necessary CTVS surgery. The necessary treatment was provided and the 5-month-old baby got the required life-saving treatment.

Case Study 2: The Story of a Student's Erased Accomplishments

The Crisis:

Shraboni Gupta (Name Changed), a meritorious student of renowned educational institution of Kolkata, found herself in the midst of a distressing situation when her ISC marksheet was withheld by the school without any valid reason. Furthermore, despite scoring 100/100 in History, she discovered that her name had been deliberately struck off the list of individuals who achieved subject-wise excellence. This act, wherein her name was initially printed and later crossed out with a pen, deeply hurt Shraboni. Despite her repeated attempts, the school administration failed to provide any justification for their actions. This created significant inconvenience and uncertainty for Shraboni regarding her future endeavours.

Intervention and Resolution:

Upon receiving the complaint, the Chief Minister's Grievance Cell intervened and engaged with the school education department to address the issue promptly. The Grievance Cell emphasised the importance of timely resolution and highlighted the violation of Shraboni's rights. The intervention led to a positive resolution, with the school administration acknowledging Shraboni's outstanding academic achievement and handing over her ISC Marksheet and certificate.

4.7 Challenges and Future Perspectives

Challenges:

- Pre-existing inefficiencies in public service delivery.
- Limited technological infrastructure and resource constraints.
- Ensuring digital literacy and accessibility for all citizens.

Future Perspectives:

- Expansion of AI and machine learning tools for predictive analysis and proactive service delivery.
- Enhanced digital literacy programs to increase citizen engagement.
- Potential for global replication in developing countries.

5. Conclusion

The grievance redressal initiative spearheaded by the Chief Minister's Office in West Bengal showcases

the transformative power of technology in governance. But, certainly, it has gone much beyond this. The significant achievement lies in the ways in which grievance-redressal has become a tool to realise the much larger objective of institutional efficiency and, in the process, building of public trust.

Research and analysis have led to multiple layers of simplification in delivery of public services. Thus, it led to reducing inertia in public service delivery, decreasing the need of multiple visits to government offices and consequent harassment, reaping the benefit of large-scale data analysis which can pinpoint implementation gaps.

Identifying gaps in implementation has facilitated the development of key initiatives such as

- Bangla Sahayata Kendra (3,571 Citizen Service Centres offering free services),
- Duare Sarkar (a government outreach program),
- Paray Samadhan (a community-based problem resolution campaign), and
- Pathashree (road construction and repair initiative).
- Samannay (an interactive platform to monitor the implementation and progress of all schemes in the state).
- Apon Bangla helping Non-resident Indians with documentation
- Migrant Workers' Welfare

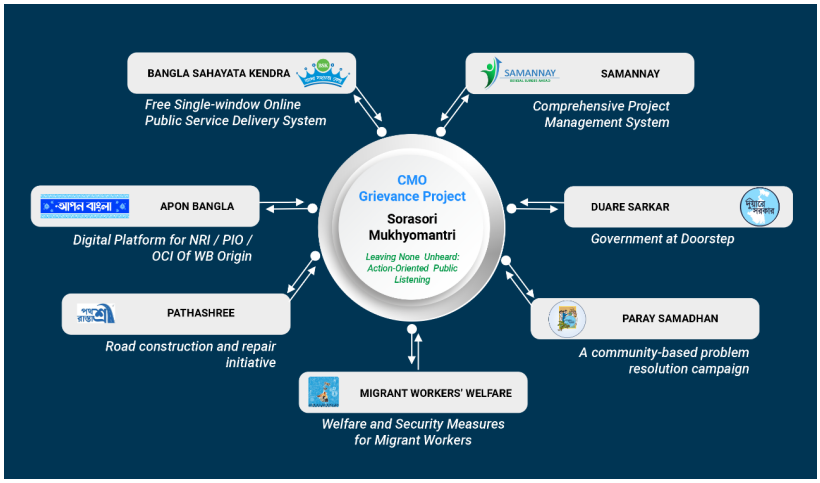

Figure 3: CMO Grievance Project

Rolling into motion an ecosystem of proactive governance, the Sorasori Mukhyomantri platform has enabled direct engagement with citizens. The grievances, suggestions, and feedback collected undergo thorough analysis, leading to actionable insights that guides policy recommendations and improves the implementation of flagship schemes. The data-driven approach has strengthened public welfare initiatives, making them more inclusive, responsive, and effective.

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CLEAN INDIAN CITIES WITH APPROPRIATE SOLID WASTE MANAGEMENT BY 2047 – PERSPECTIVE APPROACH OF PREPARATION OF SOLID WASTE MANAGEMENT PLAN FOR A CITY: SAMPLE CITY – KOCHI, KERALA

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In the run up to centenary year of India's Independence, half of the Indian population are expected to live in cities by 2047. The major hindrances in cities are congestion, traffic woes leading to air pollution, water pollution including solid waste disposal issues. Liveability Index are poor in the Indian cities due to these adverse conditions. Government of India has embarked on various Missions to improve liveability Index at par with all the cities across the globe, like Smart City, AMRUT, Swachh Bharat Mission (SBM). This clean India Mission of SBM started off in 2014, with an emphasis to improve Solid Waste Management (SWM).

The SWM needs a comprehensive planning approach. Hence, the need of SWM plan for Segregation, Collection, Transportation, Processing & Disposal of waste. It involves around principles of 'reduce, recycle & reuse' of solid waste. Forward-looking ethos pervades the SWM Plan by factoring the population projection, lifestyle and sustainable imperatives. All Urban Local Bodies (ULBs) need to take up SWM activities based on long term SWM plans to ensure that, not only cities are clean, but with adequate social & environmental safe guards.

This article is an approach paper for guidance of preparation of SWM plan of Kochi–a major city of Kerala.

Context

By 2047, when India would be celebrating centenary year of Independence, we aspire to fulfill the dream of Mahatma Gandhi, father of the nation, not only to ensure that our cities are cleaner, but, also having an appropriate Solid Waste Management (SWM) system in place. To achieve this goal, incumbent regimes have already embarked on Swachh Bharat Mission since 2014. Cleanliness drive and awareness building is already in full swing with the aim of *Viksit Bharat* by 2047. Municipal Solid Waste Management (MSWM) needs a focused approach for ensuring that our cities are garbage free. It also needs a scientific approach, a long

term planned approach to address the issue in a technically sound, socially acceptable, economically viable and environmentally sustainable way through scientific disposal of waste, from the stages of generation to the final disposal of waste.

Already many cities are aiming to address these issues and one such city is Indore, which is constantly in limelight for the best Municipal Solid Waste Management (MSWM) practices. To further encourage this endeavour, the Ministry of Housing & Urban Affairs (MoHUA), Government of India, is regularly challenging and motivating all Urban Local Bodies (ULBs) and giving them a ranking in this regard and have also instituted awards for the recognition of outstanding work done by ULBs to keep cities clean. All major ULBs are emulating the best practices adopted by Indore city.

India has more than 4,000 Tier 1 to Tier 5 cities based on population criteria. All these cities need to put in place a long-sighted plan with horizon of at least 25 years and implement Solid Waste Management (SWM) projects to make our cities clean. Although, it is a herculean task, but yet very much achievable, if all the stakeholders come together with a common goal. It should be not only Mission mode, but it should be like a citizen-centric movement.

In this regard, this article dwells on how to approach the preparation of a SWM plan for a city. For readers to understand the nuances and the nitty-gritty involved in the preparation of SWM plan and the guidelines that needs to be followed, an attempt has been made to cover the key factors involved in preparations of the plan. Further, to get a bird's eye view, without going in to the details of a SWM plan, a city like Kochi has been considered with base data that are accessible to public at large.

Part I - Approach paper for preparation of SWM plan

Generic background for SWM Plans:

A SWM plan involves joint effort of all experts, be it Environmental Engineers, Civil Engineers, Sociologists, Economists, IT and Finance professionals etc. It starts with collation of data at field level and analysis of data collected. The Gap analysis and the proposed solutions for arriving at best processes. While the experts prepare the plan, care needs to be taken to ensure that it is acceptable to all stakeholders. The citizen awareness and their involvement contributes significantly in making a plan succeed on the ground. Of course, with the main stake holders like ULBs in this case needs to own it and then only implementation would make sense. Any approach paper for preparation of a comprehensive SWM plan of a city needs guidance from National Level, similarly it should be within State's vision and legal framework. Further, it would be ideal if the Project Implementation Manual of the state implementation agency is also in place.

A. The SWM Manual Rules 2016 by Ministry of Housing and Urban Affairs (MoHUA), Government of India

The foremost important things that one needs to comprehend are the Rules of SWM and one should rely and imbibe is the SWM manual Rules 2016 (Downloadable version is available on the website of MoHUA). This manual is highly useful document for all officials who are involved in the preparation of SWM Plan Document, facilitating the achievement of environmentally sound management of Municipal Solid Waste (MSW) of cities and thereby promoting resource recovery from waste. Manual advocates a seven-step approach for proper planning and waste management of MSW. It starts with identifying the quantity and quality of MSW, local geographical

and social situations, availability of land are some other important criteria that need to be addressed. The holistic approach as defined in the manual, involving all the gamut of technical, social, economic, legal and financial aspects would help in preparation of a comprehensive Plan. The seven steps as defined in the manual has been summarised below.

- Policies, Program & Legal Frame work.
- Assessment of current situation and Gap Analysis.
- Stakeholder MSW Management and planning
- Preparation of MSWM plan
- Aspects of schedule of implementation
- Stake holders' meeting for MSWM validation
- Municipal Council approval(s) of MSW Management Plan.

The integrated MSW Management Plan strategically leads to source reduction, reuse and waste recycling including waste to composting, waste to energy and waste disposal. The role of concerned State authorities their role at regional level has been defined in the manual. The Secretary, heading the Urban Development Department of a State is fully responsible for MSWM. The State Pollution Control Boards (SPCBs) have been empowered to monitor the SWM schemes. The States may come out with their own policy and a legal frame work for guidance of Urban Local Bodies (ULBs) to be followed, while preparing SWM plans. Most importantly is ensuring that a sustainable financing model is in place, and identifying the right source(s) of funds from the bouquet of municipal revenue(s) such as municipal funds/bonds, State and Central government grants, loans from bilateral and multi-lateral development banks, and availing financial assistance from other financial institutions (banks, state and central government infrastructure funds) as well as exploring Public Private Partnership modes for sources of funding. The Capital Expenditure (CAPEX) include all the possible costs for implementation of SWM Plan-front-end fees, the capital costs, operational costs, contingent costs, back-end costs, social, environmental, including information, education, and communication (IEC) costs. CAPEX, Operational expenses (OPEX) and Replacement Expenses (REPEX) need to be included, while arriving at cost-recovery mechanisms with all the possible revenues such as user fees, penalties, sale of compost, recyclable produce, Refuse Derived Fuel (RDF), bio Compressed Natural Gas (CNG) etc. depending on selected cost proposal. The MSWM Plan implementation and statutory clearances need to be followed scrupulously and brought forward in the MSWM plan based on the facilities proposed by ULB.

B. Government of Kerala framework and Approach for MSWM

Kerala has been a leading state in India in terms of social development indices. Since 2016, GoK has been promoting a comprehensive development agenda under 'Nava Kerala Action Plan (NKAP)'. The hygienic handling and disposal of waste has been accepted as one of the central themes of the plan. For implementation of the plan, a Mission and few institutions were created. Haritha Kerala Mission (HKM) is one such initiative, and is a part of NKAP. Suchitwa Mission is another arm of GoK providing technical advisories to ULBs. Under HKM, all women oriented Haritha Karma Sena (HKS) were constituted and these in turn report to a specialised institution, namely Kudumbashree. The primary task of HKS is to provide services at door step, technical support to

Households (HHs), providing service for composting, including community composting and management of Material Collection Facility (MCF) and resource recovery facility (RRF). The HKS members are provided with personal protection equipment (PPE) Kits and are empowered to collect a set user-fee from HHs and institutions for bio and non-biodegradable waste.

The process involves primary segregation of waste using two-bin approach for bio-degradable waste (BDW) and non-bio degradable waste (NBDW) at source. As regards bio-waste, bio-bins at households' level, composting at the community level through Thumburmuzhi (TM), window, other aerobic processes have been instrumental in a de-centralised mode. Similarly, segregated NBDW is collected at prescribed interval of time (as per HKS calendar) and is brought to the mini MCF and further separation of bio and non-bio waste which is then taken to MCF and for RRF for recovery of waste leaving aside reusable waste. A total of more than 1,100 Mini MCFs have been established across the state. The ULBs have entered into an agreement with Clean Kerala Company (CKC) to collect the materials from RRF. ULBs can enter into an agreement with private agencies provided their offer is above the base price fixed by CKC.

C. Scientific advancement through KSWMP

The total solid waste generation in Kerala is estimated at 3.7 million tons annually. Of the total waste generated, the total share of biodegradable and non-biodegradable waste (NBDW) is at 69% and 31 % respectively. The biodegradable waste (BDW) has a moisture content of about 70%. It is estimated that only 20% of the BDW is treated at household or community levels, and the remaining 80% is not properly treated and disposed. Similarly, about 60% of the NBDW is dumped illegally or burned, while the remaining waste is collected informally by rag-pickers. A minor fraction is recycled at the community level. The State has no engineered landfills and/or centralised waste management facilities for municipal waste. Consequently, a major proportion of municipal waste is openly dumped in public spaces, low-lying lands and water bodies, resulting in creation of numerous illegal open dumpsites that pose serious environment and public health hazards. In order to address these issues, a scientific approach has been adopted and a specialised Institution Kerala Solid Waste Management Project has been formed.

D. The Project Implementation Manual (PIM)

The objective of the PIM is to detail the operational mechanisms and implementation arrangements for the Project to provide detailed guidance for Local Self Government Department (LSGD), Suchitwa Mission, the PMU, and the participating ULBs in executing and implementing various components of the Project. It describes the implementation processes and provides the technical guidelines, operational procedures and reporting requirements. As this is an operational document for the Project, the PIM can be revised during the Project, with the approval of the concerned authorities to provide for any additional requirements/changes that may be necessitated during the project implementation period. There is a separate PIM for procurement of goods and equipments that are expected to be purchased by ULBs based on a SWM plan.

Part – II – KSWMP's SWM intervention in the financial capital of Kerala, the Kochi city

A: Brief Introduction of Kochi the city

Kochi is one of the major cities centrally located in Kerala. It is a global city with linkages with all modes of transport including seaport and airport connectivity. The city is truly cosmopolitan with presence of many central government establishments and public sector companies. Kochi, often referred to as the financial capital of Kerala, serves as the administrative headquarters of the Ernakulam district. It stands as the second most significant port city on the western coast of India and is recognised as the commercial capital of the state.

A view of Kochi city

B: Existing Scenario of SWM facilities in Kochi

Kochi has differentiated density with the centre of the town having high density and the outskirts of the city having ample space for managing their BDW on the site. Various technologies deployed include bio-bins, bio gas, TM units, compost pits and so on. Though the collection of BDW is not regular, the management of BDW happens quite seamlessly in a decentralised manner. As far as NBDW is concerned, a good quality of source segregation makes the waste material one of the most in demand waste in South India. The HKS are instrumental in collecting the waste. It is then taken to MCF and RRF for scientific management and disposal. There is a forward linkage with govt appointed agencies.

A view of MCF at Mattancherry in old Kochi

Even in island areas, a scientific practice is followed, however, with a view to adopt a holistic approach; it is a challenge to transport the waste to Brahmapuram for centralised treatment. The waste composition has witness a sea change in last decade. Sanitary waste and diapers used by elderly people, is on the rise due to the presence of old age population in the town. There are multiple agencies providing the services on demand basis, and to be handled in a scientific way. As such, most of the houses are provided with separate bins for BDW & NBDW. In addition, the localised compost facility at source level itself is also promoted, by providing separate aerobic bins/ compost pipes.

C: Project planning and preparation

A solid waste management plan is a Document that guides the Kochi Municipal Corporation's (KMC) community's solid waste management efforts to:

- Define and understand current waste management practices and the system in place.
- Identify problems and deficiencies with in the current system.
- Identify opportunities for improvement in the current system.
- Set priorities for action to address problems and effect improvement.
- Measure progress towards deriving implementing actions.
- Identify the resources needed and develop budgets and schedules.

- Revisit and modify priorities as the plan develops.

Typical considerations related to solid waste management are:

- Protecting the natural environment.
- Complying with applicable laws and specific SWM laws.
- Protecting and conserving natural and cultural ULB resources.
- Contributing to the economic development of the ULB.
- Protecting tribal members' health and safety.

Solid waste management planning is specific to each ULB.

The following steps outline the general process required to develop the Solid Waste Management Plan.

Step 1: Develop a profile of the town area.

Step 2: Define the solid waste generators within the ULB area.

Step 3: Identify existing waste management practices within the ULB area.

Step 4: Conduct a Waste Assessment/ analysis.

Step 5: Estimate future waste generation quantities.

Step 6: Develop waste handling options.

Step 7: Identify existing regional programs or infrastructure that the ULB might use.

Step 8: Estimate costs and financial needs for waste handling operations/ options.

Step 9: Compare options based on criteria defined by the ULB.

Source reduction and landfill projects require knowledge of gross waste volumes. Recycling and waste management programs require knowledge of the quantity and composition of waste, not only for realising the value of the material, but also for developing storage and handling areas.

As per Census 2011, population of Kochi is 6,33,553 which is projected to be 6,85,460 by 2025. A high floating population in Kochi leads to a noticeable increase in waste generation, putting considerable pressure on waste management systems.

This is followed by estimating the quantity of waste generated.

The physical and chemical characteristics of the solid waste is assessed by on-site physical analysis and lab analysis for chemical parameters through National Accredited Board of Testing and Calibration Laboratory (NABL). As per the norms, a detailed inventory of waste sources such as number of households sorted by income (high, medium and low), shops, hotels, restaurants, schools, colleges, offices, markets etc in the town is prepared. Samples from different categories of households from each ward comprising of high, medium and low-income groups are collected. It is ensured that the samples are representative in nature covering all wards of different density and fringe areas of the ULB.

The physical composition of solid waste data is important for deciding the prime management options, such as reduction, reuse, and recycling. Waste characterisation study needs to be done to arrive at density of BDW & NBDW waste and to compare the per capita generation as compared with standards in the manual and the correct projected per capita waste is arrived at. This exercise is done for all the 74 wards of Kochi City, and summed up, for arriving at the design waste quantity.

KMC collects bio waste from residential and commercial establishments daily. NBDW waste is collected on a weekly basis from the houses and commercial establishments. Currently, the Corporation has minimal arrangement for collection of BDW. HKS workers collect the waste from

commercial establishments daily, but the household level collection for BDW is still poor in most of the areas. So, source level treatment is promoted. The uncollected BDW from household level is managed at source level using simple traditional methods such as pit composting, feed for cattle rearing, poultry etc. The NBDW part is stored at source and handing over the same to informal sector/scrap dealers.

Adequate arrangements are made for transferring waste from all wards to the available NBDW processing facilities, and also available vehicles are used on need basis for collection and transportation of waste from different places and the same is integrated in the SWM plan.

At present Household level waste is treated and disposed at source, using different types of compost units, kitchen bins (3 bin system), ring composting, pit composting units and biogas plants and the same is analysed and enumerated with statistical details for all wards.

KMC has 112 acres of land at Bhrahmapuram for Solid waste management. There is a centralized BSF bio-waste Management facility and windrow compost plant at Bhrahmapuram. There is another Windrow compost plant at Bhrahmapuram. The municipality has 4 MRFs at different locations in the municipality. The detailed performance and functionality along with capacity utilisation is assessed for gap analysis.

Gap Analysis is an important part of SWM plan. Once the capacity utilisation of the existing facilities, be it source level treatment, community/ institutional treatment and/ or centralised treatment is finalised, one can compare with the projected design waste quantity to know as to what additional needs to be done to the existing facilities.

This SWM Plan is prepared by assessing the existing situation through site visits, consultations with various stakeholders and from the feedback received from various workshops/meetings conducted at SPMU level. The identified gaps in each area of SWM activities in KMC is considered, and the SWM Plan is designed for a short term of 5 years period. The strategy adopted is to meet the requirement of compliance of SWM Rules 2016, State Policy, Kerala Municipal Act (KMA) and the related guidelines/manuals published by the State and Central Governments.

The proposal should also include state-of-the-art Integrated Communication Technology (ICT) with control room for intelligent fleet management, smart waste management, Mobile Apps, GIS tracking, CCTV etc. For SWM to be citizen oriented, one needs to include cost to be incurred on Information Education & Communication (IEC). Furthermore, Environment & Social Monitoring framework (ESMF), need to be put in place.

The cost-estimates need to be realistic. The cost-estimates should cover unforeseen expenses & contingencies and preferably GST should be added. The cost-estimates should not miss out any important peripheral expenses (ESMF, IEC, ICT). The cost should also include the cost of regional landfill or development works, and if there is any bio mining involved, the cost of same needs to be added.

Once the project cost is finalised, it is important to identify the possible sources of funds that needs to be pooled to meet the expenses. The CAPEX needs to be spread across the project period, based on the investment schedule. The sustainability of any proposal depends on the operation & maintenance. One need to calculate a realistic OPEX and spread it across five years of the horizon period. The cost-recovery and all possible sources of revenues need to

be projected to arrive at the viability of the project vis-a-vis expense. The cost per tonne per day for the various facilities need to be worked out. The major facility need to be seen from breakeven point of view, for both least & most efficient performance as per SWM manual.

The SWM plan needs incorporation of accepted suggestions of various stakeholders and then is finally taken up with KMC for the approval of the Council.

Conclusion:

Solid waste management is a complex puzzle with many pieces, and it is easy to get side-tracked in the planning process. Goal based management planning would help in keeping focus on the priorities. A good way to determine the goals is to develop a list of the values that the ULB cherishes, and what it wants to accomplish. Citizen responses need to be taken into consideration. Once the long term SWM plan is in place and approved, the facilities as proposed in the design period comes in to force, the solid management system should conform to the scientific disposal methods, Once, this, combined with all city level overall development works, in a cohesive manner starts taking place, it would contribute significantly to a clean & *Viksit Bharat by* 2047.

Windrow Plant at Brahmapuram Kochi

BRICKS AND BEYOND- CREATING SAFE AND RESILIENT SCHOOLS

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The Resilient School Initiative (CURE Project[1]) aims to create environmentally sustainable and disaster-resilient educational institutions by integrating water resilience and zero-waste management strategies. The project is structured around two key components: infrastructure improvement and Behavioural Change and Communication (BCC).

The infrastructure component focuses on water resilience through the implementation of Decentralised Wastewater Treatment Systems (DEWATs) with rainwater harvesting and recharging systems, ensuring efficient water management, and reducing dependence on external sources. The initiative promotes zero-waste schools by introducing compost pits for wet waste and disposal of solid waste in landfill sites with advance level of source segregation, fostering a circular economy within the school environment. Upgrading WASH (Water, Sanitation, and Hygiene) facilities further strengthen resource efficiency and resilience. The BCC component aims to instil long-term sustainable practices among students and staff. Through interactive workshops, participatory learning methods, and awareness campaigns, the initiative fosters responsible water usage, waste management, and hygiene practices. By integrating physical infrastructure enhancements with behavioural transformation, the project not only improves school environment but also empowers students as "sustainability advocates" within their communities.

This holistic approach ensures that schools become self-sufficient, provides for eco-friendly spaces, contributing to climate resilience and environmental sustainability in urban and rural settings alike.

1. Introduction

Children spend an average of seven hours per day in school. Access to safe water, sanitation, and hygiene (WASH) facilities, along with a well-maintained school infrastructure, is fundamental to creating a healthy and conducive learning environment (Unicef, n.d.) (Carmencita Tonelini Pereira,

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[1] An ongoing project of CURE in Gurugram with 7 Government Schools supported by OakNorth Foundation

2024). Schools serve as not just centres of education but also as spaces that shape children's overall well-being, hygiene behaviour, and long-term development. The physical environment and cleanliness of a school facility and appropriate hygiene behaviour can significantly affect the health and well-being of children. Every child-friendly school requires appropriate WASH initiatives that keep the school environment clean and free of smells and inhibit the transmission of harmful bacteria, viruses, and parasites.

Education is a fundamental right of every child, yet in India, the ability of children to attend and remain in school is increasingly undermined by the lack of safe and accessible water, sanitation, and hygiene (WASH) infrastructure. This issue is particularly pronounced in urban areas, where rapid population growth and uneven development exacerbate disparities in school facilities. The provision of adequate WASH infrastructure is not merely a matter of convenience but a critical determinant of health, attendance, and educational outcomes, especially for vulnerable populations such as girls and children with disabilities. In India, nearly half of all schools lack basic handwashing facilities, with only 47.6% equipped with such amenities, while 13% have no handwashing facilities at all, according to the Government of India's Management Information System for the Ministry of Education.

This crisis contributes to a troubling decline in school attendance each year, as inadequate WASH facilities lead to preventable illnesses like diarrhoea and disproportionately affect girls, who may miss school during menstruation due to the absence of menstrual hygiene management (MHM) facilities. While some private schools in urban areas boast high-quality, sustainable, and aesthetically pleasing WASH infrastructure, many others, particularly public schools, lack even the most basic provisions, perpetuating inequality in educational access. For instance, a UNICEF evaluation found that only 51% of schools in low-income countries, including India, have access to adequate water sources, and just 45% have proper sanitation—a disparity mirrored within India's urban landscape (McMichael, 2019).

While private schools in urban India often have high-quality, aesthetically pleasing, and sustainable infrastructure, a significant number of public and under-resourced schools continue to grapple with inadequate facilities. These gaps not only compromise students' health but also contribute to high absenteeism, low enrolment rates, and reduced learning outcomes. A recent survey, Community Analysis of Monitoring Schools (CAMS) carried out by the National Sample Survey Office (NSSO) reveals that India's school enrolment landscape has shifted with a rising percentage of parents preferring private education over public schools, particularly in urban areas (Banerjee, 2024).

The inadequate infrastructure in schools makes students highly vulnerable to environmental stresses, such as water scarcity and poor waste disposal, further exacerbating hygiene-related issues. Many schools rely heavily on conventional water sources (such as municipal supplies), which are often unreliable or insufficient. Additionally, the absence of effective wastewater recycling, rainwater harvesting, and solid waste management systems leads to environmental degradation and unhygienic conditions within the school premises.

2. Resilient School

Resilience refers to the capacity of the community to bounce back after a shock. A wide spread definition as coined by the community and

regional resilience institute defines resilience as "the capability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change." In other words, one needs to adapt and prepare for future adversities for minimum impact (Community and Regional Resilience Institute (CARRI), 2013).

However, when discussing water resilience, the definition takes on a more nuanced meaning within this specific context. At the city level, the C40 Knowledge Community describes a water-resilient city as one that can withstand and adapt to water-related shocks and stresses, such as prolonged droughts, flooding, storm surges, and rising sea levels (The City Water Resilience Approach, 2019). In a business context, water resilience focuses on maintaining operational stability while being cost-efficient. Investing in water resilience not only safeguards business operations but also promotes sustainable water use and a more resilient future amid climate change (Basics of Water Resilience, 2024). From a utility perspective, the emphasis is on ensuring continuous access to safe drinking water and effective wastewater treatment (Water Resilience, n.d.).

When discussing the concept of resilience in schools, the definition may vary significantly. Schools feature a distinct infrastructure, water and sanitation facilities being one of the essential components. The availability of water, both as a source for drinking and for sanitation purposes, is of paramount importance. Any disruption in the water supply can have severe consequences, leading to an unhealthy and unhygienic environment that poses health risks, discourages attendance, and negatively impacts student enrolment. Prolonged water scarcity can further exacerbate these challenges, ultimately hindering the learning process. Therefore, it is essential for schools, particularly in water-stressed areas, to establish sufficient and adequate infrastructure.

Gurugram, a rapidly urbanising megacity with a population of 30 lakh, faces severe water challenges due to peri-urban growth, reduced groundwater recharge, and contamination from untreated sewage. Unchecked development, inadequate municipal water supply, and monsoon unpredictability further threatens water security.

CURE believes that the establishment of sustainable, context-specific solutions utilising local resources is essential for enhancing community resilience. In addition to infrastructural development, the empowerment of communities—particularly children—remains a fundamental aspect. Children, as agents of change, possess the capacity to significantly influence their families and communities, thereby promoting enduring progress. By equipping them with appropriate skills, we enable them to cultivate greater bravery, adaptability, and resilience in confronting future challenges.

Acknowledging the potential of young minds, this project was facilitated by CURE and supported by OakNorth Foundation. Here when we are speaking of resilient schools, we specifically refer to the goal of achieving water resilience within the school infrastructure. This entails implementing systems that guarantee self-sufficiency in water availability. Such systems will include the treatment of wastewater and the reuse of water, thereby fostering a circular economy of water management. This approach aims to ensure that, regardless of supply fluctuations or unforeseen adverse conditions, the system maintains a consistent availability of water throughout the year.

Two government schools

were selected for the project in Gurgaon GMSPS Panchawali, Gurugram and GMGSPS, Kanhai Gurugram, Haryana with a total strength of 557 students.

The project is structured around two key components. The first aspect focuses on infrastructure improvements aimed at enhancing resilience and self-sufficiency within the school environment. This includes upgrading WASH facilities, implementing water conservation measures, and integrating sustainable waste management systems to ensure long-term resource efficiency. The second aspect involves Behaviour Change Communication (BCC) activities, designed to instil good hygiene practices among students and staff. Through interactive sessions, workshops, and participatory learning methods, the project encourages a culture of health, cleanliness, and environmental responsibility. By addressing both physical infrastructure and behavioural change, the initiative seeks to improve overall well-being and promote long-term sustainability within the school community.

3. Objective

The Resilient School project was designed to create a child-friendly, sustainable, and self-sufficient learning environment by addressing key challenges identified through a comprehensive survey. A primary focus of the initiative was to enhance water resilience by integrating Decentralised Wastewater Treatment Systems (DEWATs) for wastewater recycling and reuse in landscaping, along with the installation of a rainwater harvesting unit and a groundwater recharge pit. These interventions aimed to reduce reliance on conventional water sources, such as the Jal Board, thereby promoting long-term self-sufficiency in water management.

In addition to water sustainability, the project emphasised solid waste management through the implementation of a Zero Waste School model, integrating a Sustainable Solid Waste Management Plan with a Green Infrastructure Plan. This included the construction of compost pits for organic waste decomposition. The compost generated from the pits is utilised for landscaping of the school. A structured dry waste disposal system is established in collaboration with the municipal waste collectors. Furthermore, the project upgraded child-friendly WASH infrastructure, including the retrofitting of toilets, installation of handwashing platforms, and provision of dedicated drinking water stations, along with landscaping improvements to create a conducive learning atmosphere.

To ensure the long-term success of these interventions, the project incorporated capacity-building programs for both staff and students, focusing on hygiene education, sanitation practices, and behaviour change communication. By engaging students in decision-making processes through regular cabinet meetings, the initiative fostered a sense of ownership and responsibility. Ultimately, the project aimed to establish a safe, healthy, and supportive school environment, fostering the holistic development of students while equipping them with essential knowledge and skills for sustainability and resilience.

4. Methodology

The project follows a structural approach, focusing on environmental sustainability and reusing the resources. Followed up by shortlisting the schools based on need of infrastructure, and behaviour change communication of children through profile assessment and transect walk for vulnerability assessment. The insights gathered during the transect walk feed into stakeholder discussions with teachers,

students, parents, and staff, ensuring a comprehensive understanding of challenges. Through issues identification, resource mapping, and participatory learning, practical solutions are implemented. The process includes monitoring and evaluation to ensure long-term sustainability, ultimately transforming schools into resilient, zero-waste, and water-efficient environments.

5. Findings

A. Existing condition

An assessment was conducted at both schools to identify the issues and challenges faced by students and children. The schools faced various difficulties concerning water infrastructure, green spaces, WASH (Water, Sanitation, and Hygiene) facilities, and behavioural practices. These challenges had a substantial impact on the learning environment and the overall well-being of the students.

1) Water Infrastructure Challenges

The schools lacked essential water storage infrastructure, with no rainwater harvesting systems or reservoirs established. The water supply was inconsistent due to the absence of a motor and the presence of uncleaned tanks with clogged connections. Furthermore, there were no separate structures for handwashing and drinking water, resulting in considerable water wastage. At GMSPS Panchawali, only one drinking water unit was available, with just two functional taps. GGMPS Kanhai also struggled with limited water access, providing only 200 litres daily, thus exacerbating hygiene issues.

2) Sanitation and WASH Infrastructure Deficiencies

Both schools encountered significant issues with their toilet facilities. At GMSPS Panchawali, only four toilet pans were functional, and two of them were clogged. The flush tanks were broken, and the water availability was insufficient at just 500 litres. The school lacked boys' urinals, had broken handwashing basins, and there were missing taps inside the toilet cubicles.

Similarly, at GGMPS Kanhai, only three toilet pans were operational, but they suffered from waterlogging and blockage issues. Additionally, the school lacked electricity, resulting in dark and unsafe areas. Plumbing problems, broken tiles, and damp structures further compromised the hygiene and usability of the WASH facilities. Furthermore, there was no proper wastewater management system or composting unit in place, leading to serious environmental and hygiene concerns.

3) Lack of Green Spaces and Poor Waste Management

Both schools exhibited significant deficiencies in green cover, with approximately 3,163 sq. m. of open areas being paved. This lack of vegetation contributed to excessive heat and dust accumulation, resulting in a dry and unwelcoming environment.

Waste management was also severely inadequate. There was no system in place for the segregation of dry and wet waste, leading to the accumulation of mixed waste, which totalled around 16-18 kg per day. Furthermore, the absence of composting solutions and proper disposal methods posed critical environmental hazards and health risks to the school community. These issues highlighted the urgent need for improvement in both green spaces and waste management practices.

4) Behavioural and Awareness Gaps

Students and stakeholders exhibited a significant lack of awareness regarding proper WASH (Water, Sanitation, and Hygiene) practices, which contributed to unhygienic conditions within the schools.

A survey conducted at the time revealed that 46% of students were unaware of the importance of hygiene, and many were unfamiliar with the correct usage of WASH infrastructure. There was no structured approach to waste management, no trained personnel available to maintain the infrastructure, and a distinct absence of ownership among both students and staff. Additionally, community engagement in WASH-related activities was minimal, with no awareness campaigns or regular monitoring of hygiene practices being implemented.

The lack of proper water and sanitation infrastructure significantly limited green spaces, while the absence of awareness among students and staff created serious challenges in establishing a healthy and resilient school environment. Addressing these critical gaps through infrastructure upgrades, improved waste management solutions, and behavioural change initiatives was essential for enhancing overall school resilience and ensuring a safe and sustainable learning space for students.

B. Interventions

The project implemented key interventions to enhance the school environment. The following measures were undertaken in both schools:

- **Water Resilience and Sustainable Management** – Implemented rainwater harvesting, groundwater recharge, and decentralised wastewater treatment systems (DEWATS) to improve water availability, stormwater management, and water reuse while ensuring low-maintenance solutions for long-term sustainability.
- **Waste Management and Green Infrastructure** – Conducted waste audits, promoted waste segregation, and introduced composting techniques to manage organic waste effectively. Green initiatives such as tree plantations, green roofs, kitchen gardens, and urban farming campaigns were undertaken to enhance environmental sustainability.
- **Infrastructure Upgradation and Hygiene Facilities** – Repaired and upgraded child and gender-friendly toilets, drinking water platforms, handwashing stations, and sanitation infrastructure. Improved school aesthetics through landscaping, play areas, and interactive spaces while addressing crumbling infrastructure issues like roofs, boundary walls, and classroom interiors.
- **Behavioural Change and Capacity Building** – Introduced theme-based educational activities on water conservation, pollution awareness, and sustainability. Revitalised school environment clubs and student cabinets while conducting capacity-building sessions for teachers, sanitation staff, and Parent-Teacher Associations to ensure active participation in school hygiene and environmental initiatives.

C. Strategies Adopted for Sustainability

To ensure the long-term impact of the project, various sustainability strategies were implemented. One of the key approaches was the formation and regularisation of class cabinets, managed by school staff, to instil a sense of responsibility among students. Additionally, an operation and maintenance committee was established to oversee the upkeep of the WASH infrastructure, ensuring its functionality over time.

Capacity-building played a crucial role in sustaining the interventions. Training sessions were conducted for key stakeholders, including School Management Committee (SMC) members, staff, parents, and students,

to enhance their knowledge and engagement in hygiene and sanitation practices. Community participation was also encouraged, fostering a sense of ownership and involvement, which contributed to the long-term sustainability of the project.

D. Outcome

The project interventions led to a significant improvement in the school environment, resulting in increased student attendance, reduced health-related absences, and enhanced engagement by fostering a cleaner, safer, and more inclusive learning space. Additionally, the development of rainwater harvesting systems, groundwater recharge units, and decentralised wastewater treatment systems (DEWATs) strengthened water resilience within the schools, ensuring a sustainable and reliable water supply for daily use, emergencies, and environmental conservation. The following table shows the impact of the actions taken in the school.

Table 1: Impact of the project

Objective	Sector	Impact
Water Resilient School	Water	8,000 Liters of water reserved
		Ground water recharges 10,000 Litres of water annually
		Using DEWATs to recycle and reuse 89,600 Litres of water annually
		Water available throughout the year
		Hand washing platform
		Drinking water platform
Zero waste School	Sanitation	Reduction in solid waste generated in the school
		Proper segregated waste disposal by students
Green School	Environment	Compost prepared from the wet waste from school used in plantation.
		Reducing dark spaces, increases green spaces
Upgrading WASH Infrastructure	Infrastructure development	Retrofitted toilet infrastructure- reduction in open defecation
		Construction of Compost pit
		Construction of DEWATs
		Rainwater harvesting and Groundwater recharging units- water conservation and recharging
		Access to safe drinking water
		Improved water quality
		Improved hygiene habits- hand washing platform
Behavioural Change and Communication	Behaviour development	Developed hygiene habits in the students, and community 6% reduction in sick leave

Figure 2: Compost pit- to tackle wet waste and turn it into manure

The average attendance of students showed a noticeable increase following the implementation of various interventions aimed at improving the school environment.

The creation of a cleaner, healthier, and more student-friendly atmosphere through enhanced sanitation, green

Figure 3: DEWATs with Handwashing platform for Reusing the grey water in landscaping

Figure 4: Drinking water platform and Handwashing platform

spaces, and improved WASH infrastructure contributed to a more conducive learning environment. The availability of functional child-friendly toilets, handwashing platforms, and drinking water stations reduced health-related absences by minimising the risk of infections and waterborne diseases. 6% reduction in the sick leaves were observed and reported by the teachers as per the Audit report collected on ground.

Before:

After:

Figure 5 Infrastructure upgradation

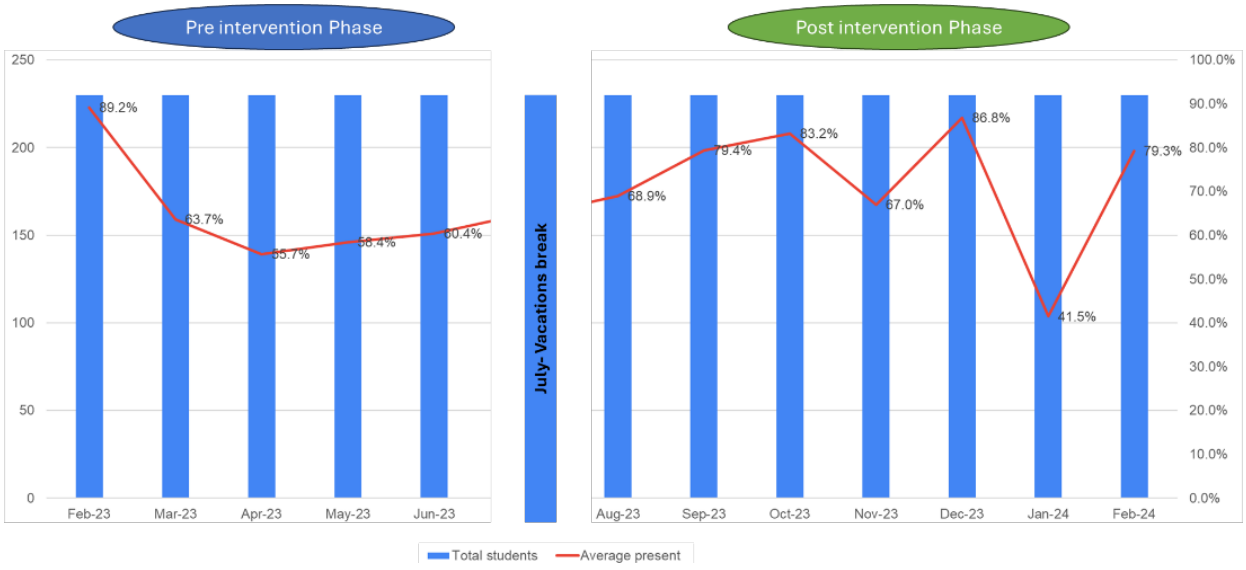

Figure 7: GSPS Panchawali updates on attendance data

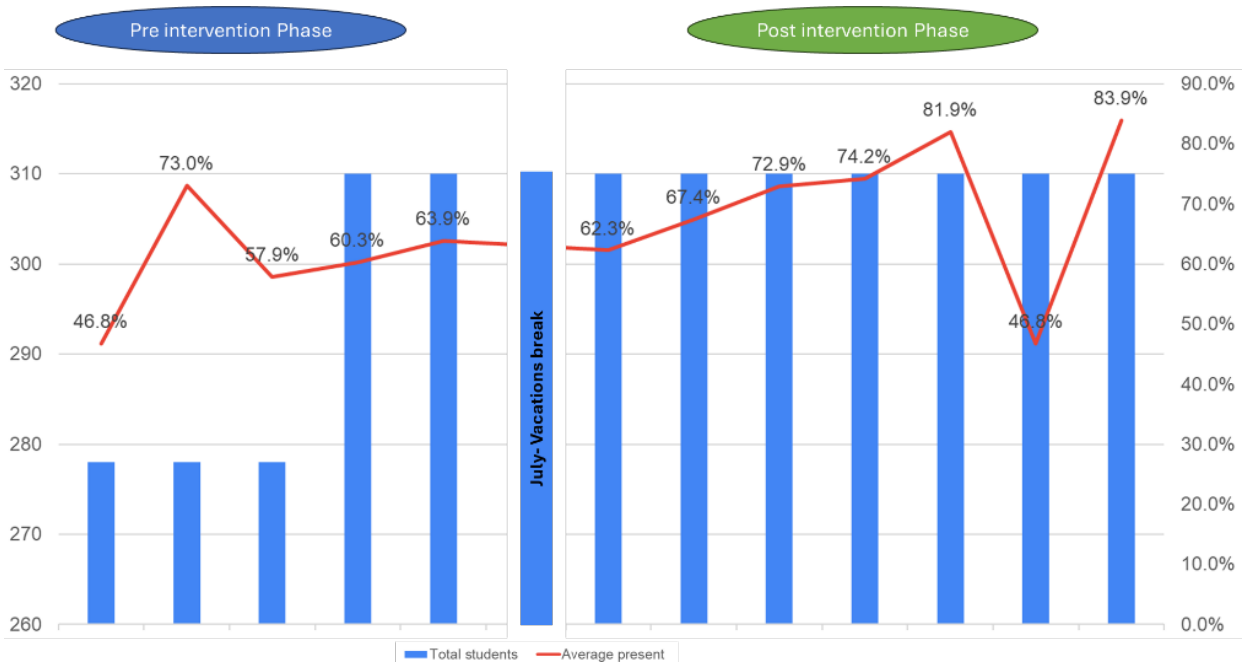

Figure 8: GGMPS Kanhai updates on attendance data

6. Discussion

The project has significantly enhanced the environmental sustainability and hygiene conditions of both schools, aligning with five key Sustainable Development Goals. One of the most notable outcomes was a 6% reduction in staff sick leave, as recorded in attendance registers over the past five months. This improvement is attributed to the cleaner, more hygienic environment established through targeted interventions, reducing health risks and promoting overall well-being.

Creating a harmonious and student-friendly school environment was a key focus of the project. The initiative increased green cover within school premises by planting 150 saplings, reducing dark spaces through improved lighting, and engaging students in wall-art and painting activities. These efforts not only enhanced the aesthetics but also fostered a sense of ownership and pride among students, contributing to their overall mental well-being and engagement in school activities.

A significant achievement was the development of WASH infrastructure, including child-friendly toilets, handwashing platforms, drinking water stations, DEWATS (Decentralized Wastewater Treatment Systems), an 8,000 litre Rainwater Harvesting Unit, and a 10,000 - 12,000-litre Groundwater Recharge Unit. The construction of functional child-friendly and staff toilets resulted in a measurable reduction in open defecation within school premises, ensuring better sanitation and dignity for students and staff. Additionally, handwashing stations coupled with behavioural training contributed to reduced drinking water wastage and the adoption of healthier hygiene habits. Students have now started bringing soap, handwash, and napkins as part of their daily routines, indicating a sustained behaviour change.

The installation of a drinking water platform has significantly improved water management by ensuring efficient access to drinking water while preventing

unnecessary wastage. Previously, the water tank would be empty before the end of the school day, leaving students without access to drinking water. With the new system, water consumption is optimised, ensuring availability throughout the school hours.

Furthermore, the rainwater harvesting unit serves as an alternative water source, supplying up to 8,000 litres of stored water, which is equivalent to a 15–16-day supply based on the school's daily consumption of 500 litres. This intervention strengthens the school's water security and resilience, particularly in emergencies such as fire breakouts or temporary water shortages. Additionally, the groundwater recharge system replenishes 10,000 litres of water annually, contributing to long-term water conservation efforts.

The introduction of two DEWATS units has enabled the reuse and recycling of 89,600 litres of wastewater annually for landscaping and toilet flushing. This system ensures that wastewater is effectively treated and repurposed, reducing reliance on freshwater sources. Similarly, a composting system was established to process organic waste, significantly reducing the amount of solid waste generated within the school. The compost produced is used to enrich soil quality in the school's newly developed green spaces, reinforcing sustainable waste management practices.

The transformation of previously paved school grounds into green spaces has had multiple environmental and social benefits. By incorporating green infrastructure, the schools now act as urban green lungs, improving air quality and enhancing biodiversity. These efforts promote climate resilience while fostering environmental conservation awareness among students. Additionally, the project has successfully instilled long-term behavioural changes in students regarding hygiene and sanitation practices. By assigning students roles and responsibilities to regulate cleanliness, they have taken proactive measures such as bringing soap and napkins for handwashing. This sense of responsibility and peer-driven engagement ensures the sustainability of the project's impact beyond its initial implementation.

7. Challenges Faced

The project faced various challenges, largely stemming from the constraints imposed by government institutions. A significant issue was the limited availability of resources, which hindered the effective execution and upkeep of interventions. Moreover, the absence of dedicated personnel and inadequate funding for operation and maintenance complicated the sustainability of newly established infrastructure.

Financial contributions from parents posed another challenge, given that many were from economically disadvantaged backgrounds. While they could not offer monetary support, they participated actively and contributed in the form of labour. Additionally, a lack of awareness surrounding hygiene, sanitation, and appropriate behavioural practices undermined the success of WASH-related initiatives. The restricted access to information on hygiene and sanitation exacerbated these challenges, highlighting the need for focused capacity-building efforts.

8. Conclusion

The idea of a resilient school acts as a foundation for empowering students by offering a safe, healthy, and supportive learning environment. Since children spend almost one-third of their day at school, it is essential to foster a setting where they feel secure, comfortable, and eager to learn. A well-kept school, equipped with proper WASH facilities and green areas, not only promotes students' physical health but also encourages their sense of responsibility towards sustainability and community development. By cultivating this environment, schools transform from mere

educational institutions into spaces that promote overall growth, encourage positive behaviours, and motivate students to make meaningful contributions to society. The initiatives implemented in this project have shown that resilient schools are vital in shaping young minds, preparing them to become responsible citizens capable of instigating future change. Therefore, investing in resilient school infrastructure is not just an improvement of educational environments but a crucial step towards building a stronger, healthier, and more sustainable future for the nation.

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Kochi Water Metro

Kochi Water Metro is a state-of-the-art, environmentally friendly water transport system that connects Kochi's island communities with the mainland. The Water Metro network is equipped with a fleet of 78 battery-operated electric hybrid boats, with capacity of upto 100 passengers, serving 38 modern terminals across 15 routes, for a total distance of 76 kilometres the Kochi Water Metro started its commercial operations in April 2023 on two maiden routes: High Court to Vypin Island and Vytilla to Kakkanad. In April 2024, three more routes have been added: High Court to Fort Kochi, High Court to South Chittoor, and South Chittoor to Cheranalloor. To date, more than 2.5 million passengers have already used the services via its five routes. Once fully operational in 2035, the Kochi Water Metro will connect 10 island communities with Kochi's mainland and serve about 100,000 passengers daily, thereby providing them with fast, reliable and eco-friendly water transport. The installation of security, surveillance, communication and emergency response systems has helped to ensure the safe operation of the network. An automatic passenger control system has further prevented overcrowding in boats, a primary cause of accidents in water transport.

The boats have been designed and constructed in a way that lowers their environmental impact through use of lightweight and recyclable materials, together with a low draft and wake design, resulting in reduced power consumption and noise emissions, thus limiting disruption to the flora and fauna in the waterway. To respond to tidal variations and future increases in sea level, all terminals and jetties have floating pontoons to ensure safe boarding amid any change in water levels. The use of electric propulsion for the boats has further reduced greenhouse gas emissions by at least 22,400 tonnes per year upon full implementation. Kochi Water Metro further aims to achieve 100 per cent renewable energy operation through a 17 megawatt peak (MWp) solar plant.

The Kochi Water metro has been implemented as part of an integrated transport sector strategy with special attention to feeder systems and connectivity with other modes of transport. By locating the ferry terminals in close vicinity of other modes like buses, the metro rail, auto-rickshaws, and other feeder systems, the scope for increased ridership has been greatly accelerated. The project is owned by the Kerala state government, which has contributed US$21.7 million to the project's viability gap.

Despite the benefits of inland waterway transport, many cities have yet to harness its full potential. The Kochi Water Metro offers a prototype of how other cities may revitalize their water transport and elevate it to include climate change considerations and principles of sustainable urban development.

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The following checklist should be used when preparing an article for submission. Please be sure to follow the specifications exactly and completely to ensure that your article is reviewed in a timely manner and any delays avoided further along in the publishing process should your article be accepted for publication.

1. The paper should be created using a word-processing programme (such as Microsoft Word) and should be between 3,000 and 5,000 words in length. The file may be in .docx or .doc format.
2. The paper is typewritten, double-spaced, and formatted to print on 8.5"x11" (or A4) size paper. It is written in the third person in a clear style, free of jargon.
3. The first page of the article includes the following :
   i. the paper's title; and;
   ii. an approximately 200 word abstract that emphasises the paper's contribution to the field and its practical architectural/planning/ social / economic implications.
   iii. the name(s), position(s), professional or academic affiliation(s) and email address(es) of the author(s) as well as the full postal address of the corresponding
4. The body of the paper should include the following:
   i) An introduction to the subject;
   ii. background information;
   iii. discussion of procedure;
   iv. results;
   v. conclusions;
   vi. implications for practice and advancement of research.
   vii. references;
   viii acknowledgements (Optional), if funding for the research was received from non-personal sources, the sources must be identified in this section), and;
   ix. an autobiographical sketch.
5. Please ensure that :
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   ii. Reference citations in the text are referred to by author name and year. If there are more than two authors, the name of the first author followed by "et al." has been used.
   iii. References contain the following information, in the order shown : names of all contributing authors (last name followed by first initial), date of publication, title of article, names of editors (edited books only), title of author
   journal or book, volume and issue numbers (journals only), location and name of publishing company (books only),and inclusive pages (journals and articles in edited books).
   iv. Figures/pictures/graphs submitted are :
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      d. Please ensure that scanned images are of a high resolution to ensure good quality printing (not less than 640 x 480).
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